ENGINEERING AND MINING JOURNAL

A McGRAW-HILL PUBLICATION

APRIL 1958

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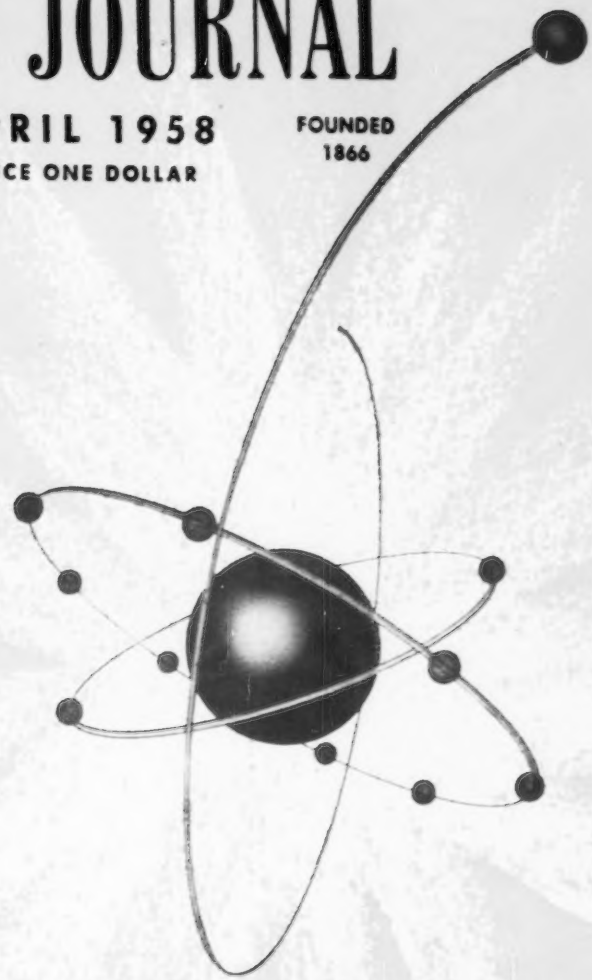
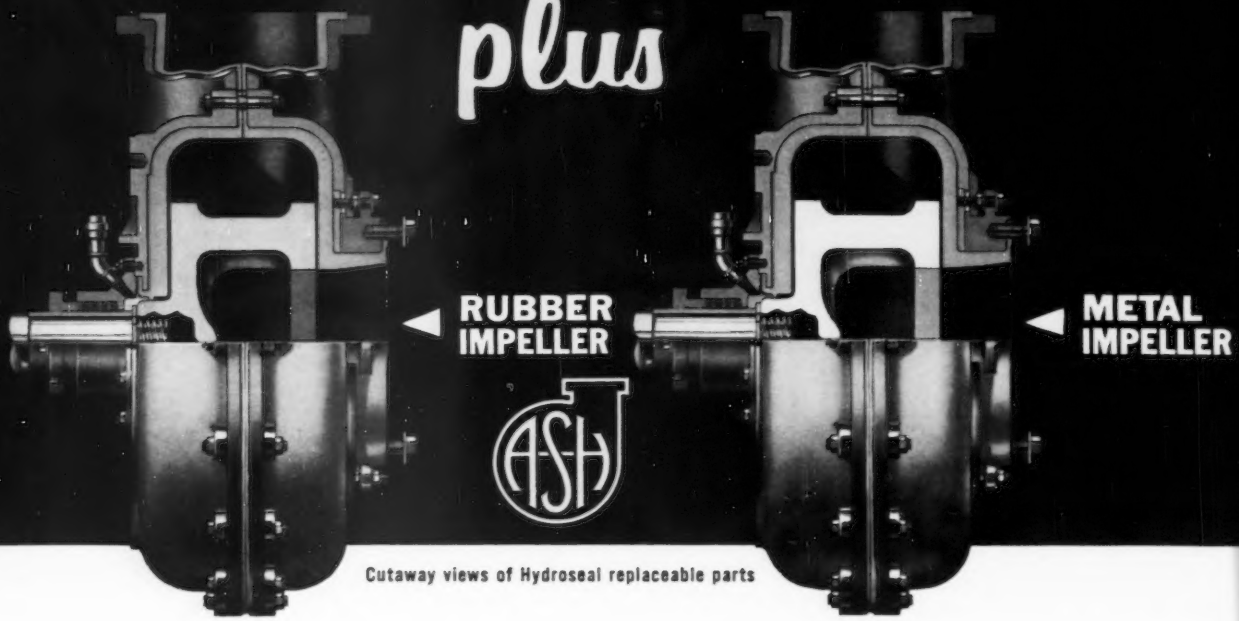


ELECTRONS AND IONS

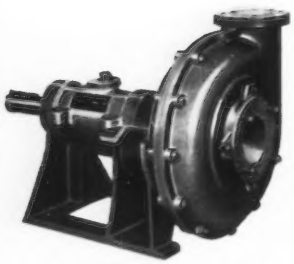
keys to mineral processing

INTERCHANGEABILITY *plus*



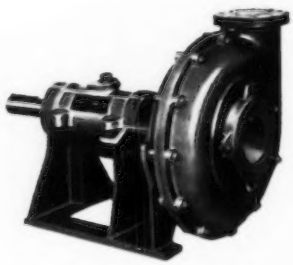
Cutaway views of Hydroseal replaceable parts

Alloy impellers are available as part of the numerous interchangeability features of Hydroseal and Centriseal Rubber-lined Slurry pumps. For maximum abrasion resistance, we use A-S-H—21, a superior-type NI-HARD; for corrosion resistance, a variety of alloys.



In the Hydroseal, the gland is protected from abrasives by a flow of sealing water.

Write for Brochure No. 457.



In the Centriseal, auxiliary vanes on the impeller make sealing water unnecessary.

Write for Brochure No. 557.

THE ALLEN-SHERMAN-HOFF PUMP CO.
Dept. B—259 E. Lancaster Ave., Wynnewood, Pa.
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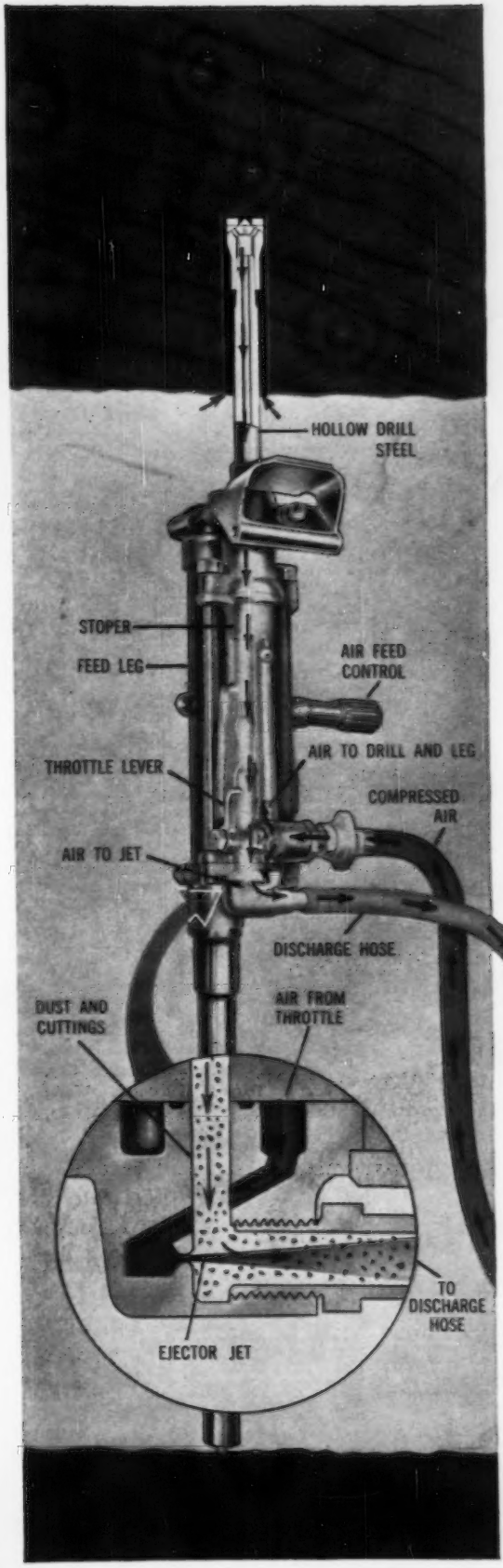
SAND, SLURRY & DREDGE PUMPS
MAXIMIX RUBBER PROTECTED



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VACUJET

DUSTLESS STOPER

offers all these
cost-saving advantages
for roof bolting

Designed from the ground up for dry dustless drilling, with built-in jet vacuum and pressure discharge, the Ingersoll-Rand RP38E VACUJET dustless stoper is setting entirely new standards of performance and economy. Here's why:

Strongest Suction Power — vacuum is produced, right in the drill itself — not 25′ away. Will even remove cuttings on horizontal holes!

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Lower Bit-Shop Costs — tapered bit end and plain shanked drill steels eliminate need for furnaces, threading and forging equipment.

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ENGINEERING AND MINING JOURNAL

92nd YEAR OF PUBLICATION

APRIL 1958

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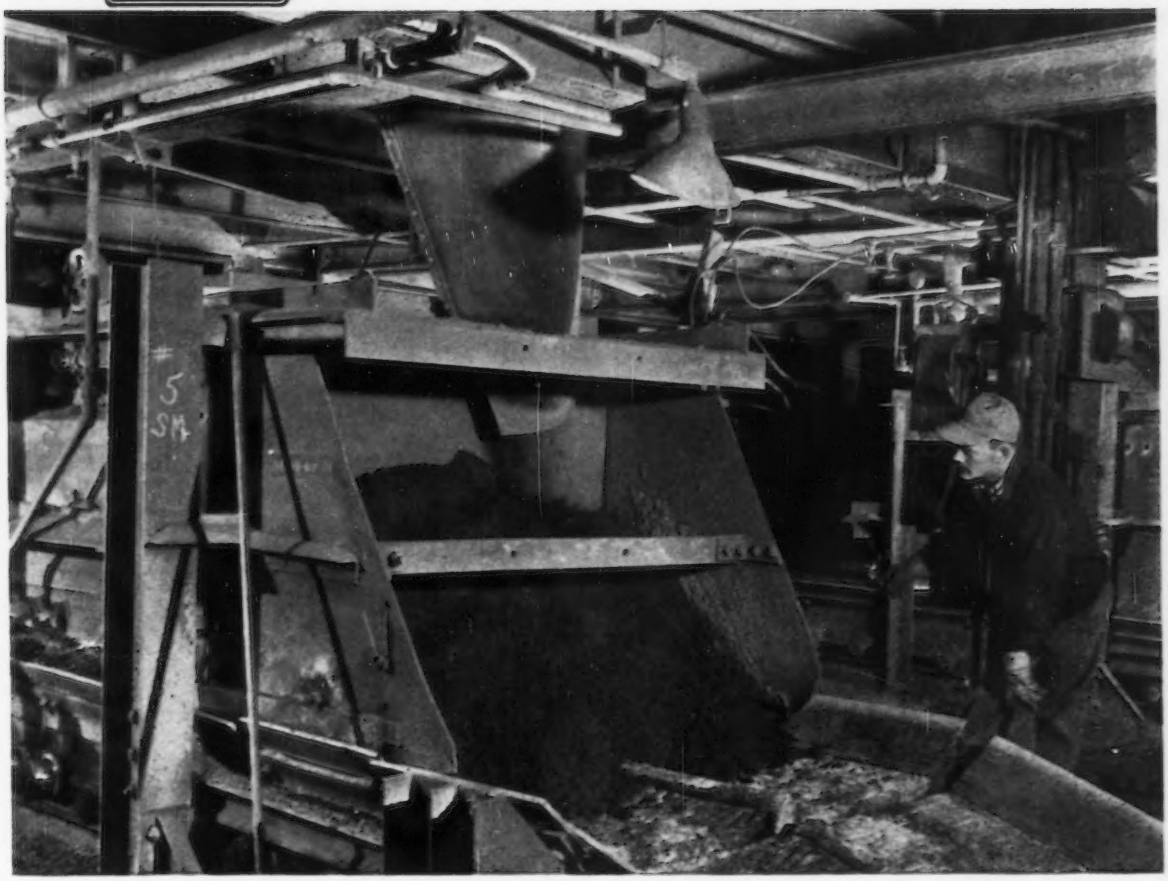
B.F.Goodrich



How rubber chutes save $8000 to $10,000 a year

B. F. Goodrich improvements in rubber brought extra savings

Problem: That black stuff pouring out of the chute was causing plenty of trouble in this zinc plant. It's a highly abrasive sinter mix—wet, hot, and so corrosive it would eat through metal. It was wearing out chutes, made from pieces of conveyor belting, in a few weeks.

What was done: When a B.F.Goodrich distributor heard about the problem, he recommended that the chutes be made with a special kind of B.F.Goodrich rubber sheeting, called Armorite, that's especially compounded to stand terrific abrasion. This rubber is so tough, it's even used in some places to handle broken glass.

Savings: Plant men first estimated that the Armorite would last four to six times as long as the chutes previously used, and save $8,000 to $10,000 a year. Now they say it is lasting about 8 times as long. No more maintenance problems.

Extra benefits: B.F.Goodrich Armorite can be used in dozens of ways—as a liner, curtain, throw mat or pad for protection against abrasives. Can be ordered with or without a reinforcing back of fabric, fibre or steel. It often lasts 10 times longer than steel; eliminating frequent, costly replacements of abrasion-worn metal parts.

Where to buy: Your B.F.Goodrich distributor has full information on Armorite. And, as a factory-trained specialist in rubber products, he can answer your questions about *all* the rubber products B.F.Goodrich makes for industry. *B.F.Goodrich Industrial Products Co., Dept. M-295, Akron 18, O.*

B.F.Goodrich industrial products

Behind the By-Lines . . .

In the middle of a discussion a couple of days ago we turned to our friend Jim Franklin and said, "Take a brand new process like ion exchange . . ."

"T'aint new," says Ol' Jim. "T'aint?" says we. "Nope," says he, reaching for a pencil . . .

We're going to be more careful in the future. Before he got through explaining, scribbling and diagramming we had sixteen pages, a cover and a pretty hot subject for your careful study.

Electron transfer and ion exchange are not new to mineral processing, even though they may be finding more and newer applications daily. Ol' Jim has compiled, starting on p 85, just about all you need to know on the subject, from metallurgical law down through the many exciting applications which the processes are finding in this wide open field.

When you get back to page 17, would you mind taking a look at our latest innovation? We're experimenting with a coming thing in magazine publishing: perforation of special sections.

The entire eight-page form on yellow stock has been perforated for your convenience. If the idea seems to catch on, we'd like to try it on our special reports and studies.

We'd appreciate a note from you on the idea. Do you think it makes the magazine more useful? Or, let us know if the whole idea appalls you.

That Nuclear Age cover seems to have inspired us. This month's issue seems dedicated more than ever to the new and exciting as well as the meaty and technical.

Item: In the above-mentioned Electrons and Ions story there's a section that could only be called "Blue Sky" metallurgy. Read it carefully, remembering that yesterday's slag pile is today's nylon stocking.

Item: A gentleman named Theodore Nagel got impatient with inefficiency in grinding results. His thesis is that friable solids perform their best work when they're working on each other. You'll find your thinking stimulated by the article on p 110.

Item: Newest member of *E&MJ's* Out-On-A-Limb Society is F. C. Fearing. His long-range forecast for nickel starts on p 106.

Item: You've probably got rocket fuels and solid fuels clear up to here by now, but we doubt if you've read about as nicely integrated an operation as that of U.S. Borax. From pit through refinery, with refinements, the story begins on p 101.

Item: The earthmovers are at it again. We've had to forego a "Trends" page this month and start "This Month in Mining" one page earlier. —And we had to trade on the innate good humor of our printer, our Pacific Coast News Bureau, and the folks at the University of California radiation labs at Livermore.

A couple of weeks ago the AEC sponsored the underground detonation of an atom bomb—not to test the bomb's destructive force, but to test its efficiency as a mover and crusher of earth.

The results are pretty spectacular, and with the kind forbearance of all of the above-mentioned, including an AEC clearance officer, the story begins on p 21 with charts and drawings.

It's all part of the Atoms-For-Peace program of the U.S. Government. With that in mind, we can understand the designation "Plowshare." But they called the shot "Rainier." Is that *our* Rainier or the publicized proud papa of the principality of Monaco?

We've had mild attacks before, but this time it's serious. Where do you go for a severe case of chagrin?

Received the following correspondence from Dr. Nicholas VanSerg, via Prof. H. E. McKinstry of Harvard's Laboratory of Mining Geology:

> Sir:
>
> After reading *E&MJ* news notes last few years, find self unable write connected English so please forgive jitters.
>
> Technical articles hard enough to read anyhow without telegraphese or baby talk to decipher. What's idea? Save space?
>
> How can we teach students write well with such model? Give us break

The doctor had us; game, set and match. We admit, ruefully that the desire to compress as much information as possible into *E&MJ's* pages has led us somewhat astray. English is still, as Professor Henry Higgins observes to Liza, "the language of Milton, of Shakespeare, of the Bible."

All right, lads, there'll be a full staff meeting tomorrow morning!

Incidentally, Doc, a group of lit'ry types some time ago chose what they considered the most beautiful lines in the English language. They selected the last two lines of Samuel Coleridge's "Kubla Khan" —"For he on honeydew hath fed/And drunk the milk of paradise." The runner-up in the competition was not, as some of your colleagues have suggested, "Harvard 48—Yale 0."

If you'll forgive a sad and sentimental note, we'd like to call attention to the death, a few months ago, of Joe Frisco, one of the world's great wits. He was quoted widely, and little known outside of his craft.

Joe was slight of build, sad-faced, and affected a stammer. His funny, funny lines were not the work of a hired gag-writer, they were his own. And they were truly witty—and timeless.

It was Joe who said, "I went to Philadelphia once. But it was closed." And, on the way to the racetrack, "I hope I break even today. I need the money."

He was an inveterate gambler and the bangtails were his ruination. "H-h-had a g-g-good day at the t-track t-today. Fella g-g-gave me a r-ride home."

RIPPING DIGGING

This CAT No. 977 Traxcavator increased production 30%

Dixie Mines, Inc., one of the nation's largest producers of hi-grade mica, was using a competitive machine until last year in one of their mines. This mine, near Heflin, Alabama, is under the direct operating supervision of the firm of Bailey and Van Horn. Then a Caterpillar No. 977 Traxcavator with No. 6 Ripper was put to work. Result:

"By using the No. 977 we have upped our production 30%," says Joe W. Bailey, resident manager. "It loads faster, lifts faster and is mobile. Besides working the overburden and the mica bearing pegmatite, we use it to feed the mill at night, build dams, maintain roads and many other jobs. It's a good all-around machine—and we're happy with the freedom from down time and low cost of operation."

The No. 977 rips the tough pegmatite then loads it into trucks. During a ten-hour day, production averages 500 cu. yd. The material is put through a jaw crusher, washed and screened, leaving a concentrate of mica as residue.

The No. 977 works at such a money-making pace because it's built from the ground up as a loader-excavator, not just a tractor with bucket attached. About 26 sq. ft. of ground-gripping track provide tremendous traction to crowd the 2¼-yd. bucket full every time, get away fast.

In addition, operator comfort means that this fast pace is maintained. He has a high seat with excellent visibility of all bucket positions. Controls are easily reached—bucket control a one-hand operation.

Your Caterpillar Dealer has three sizes of Traxcavators in his line. Get the full story on them today. Have him demonstrate on your job. Count on him for fast service and quality Caterpillar parts.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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THE NO. 977—POWER AND VERSATILITY FOR MINING

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It's a heavy load, a fast lift—but wire rope stays strong, longer, because it's fully protected by Texaco Crater

That's because Texaco Crater penetrates to seal the core. At the same time, it surrounds the strands and separates them with a tight protective film. This sturdy film protects the rope against internal and external friction—and wear. And because the film adheres so tightly to metal, it prevents corrosion and rusting.

This same lubricant does double-duty on open gears, too. It clings to the teeth, won't ball up or throw off, cushions against shock and heavy loads, and acts to prevent wear.

Operators who prefer the spray method of application use Texaco Crater X Fluid—for both wire rope and open gears. This outstanding, convenient product *goes* on as a liquid (no heating required), and *stays* on just like the regular Crater. Gives the same fine long-lasting protection.

Texaco Crater and its spray-on counterpart, Texaco Crater X Fluid, are only two of Texaco's complete line of famous products for mining equipment. Let a Texaco Representative help you draw up a Simplified Lubrication Plan for all your mining equipment. Call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

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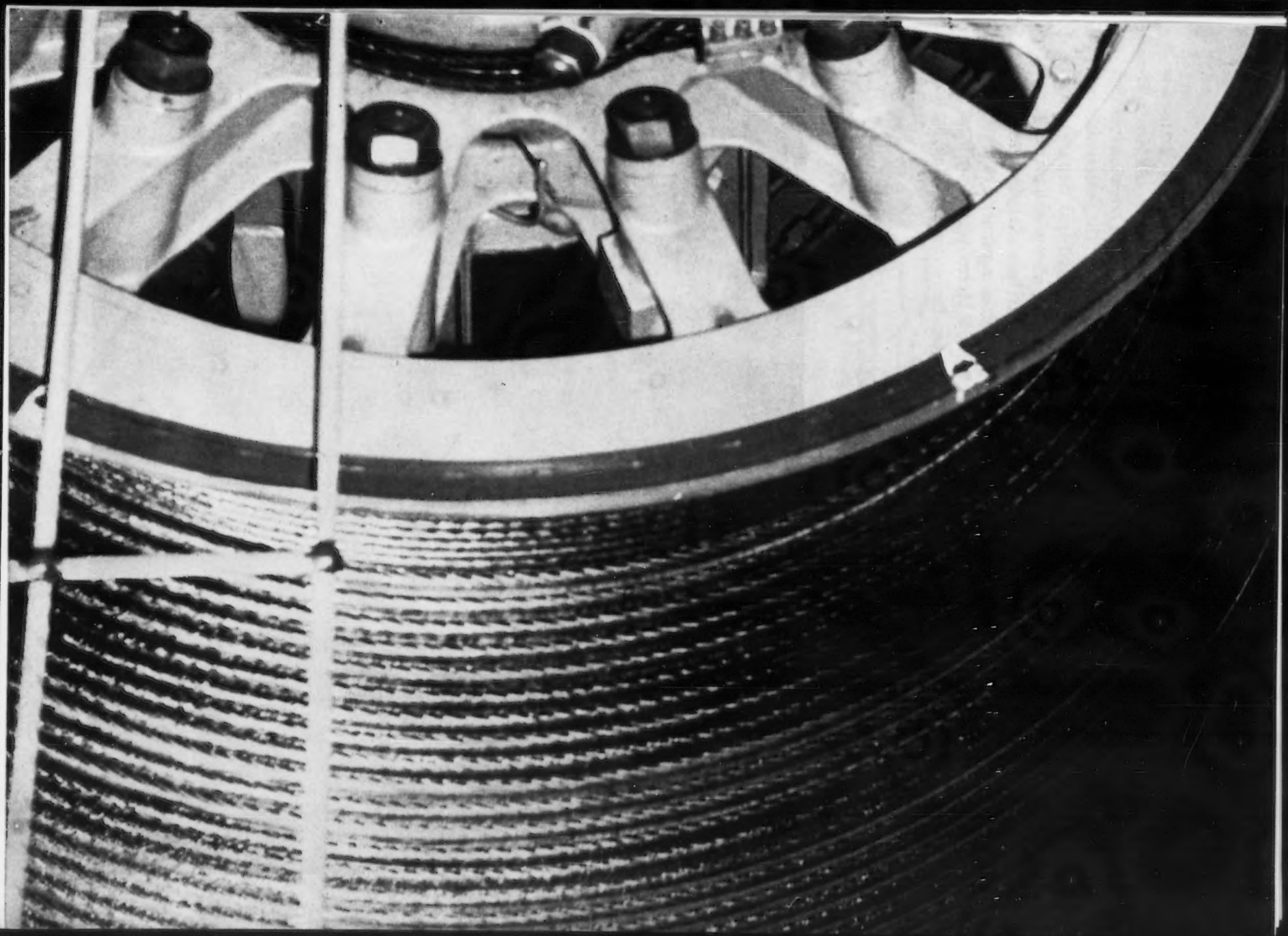
LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

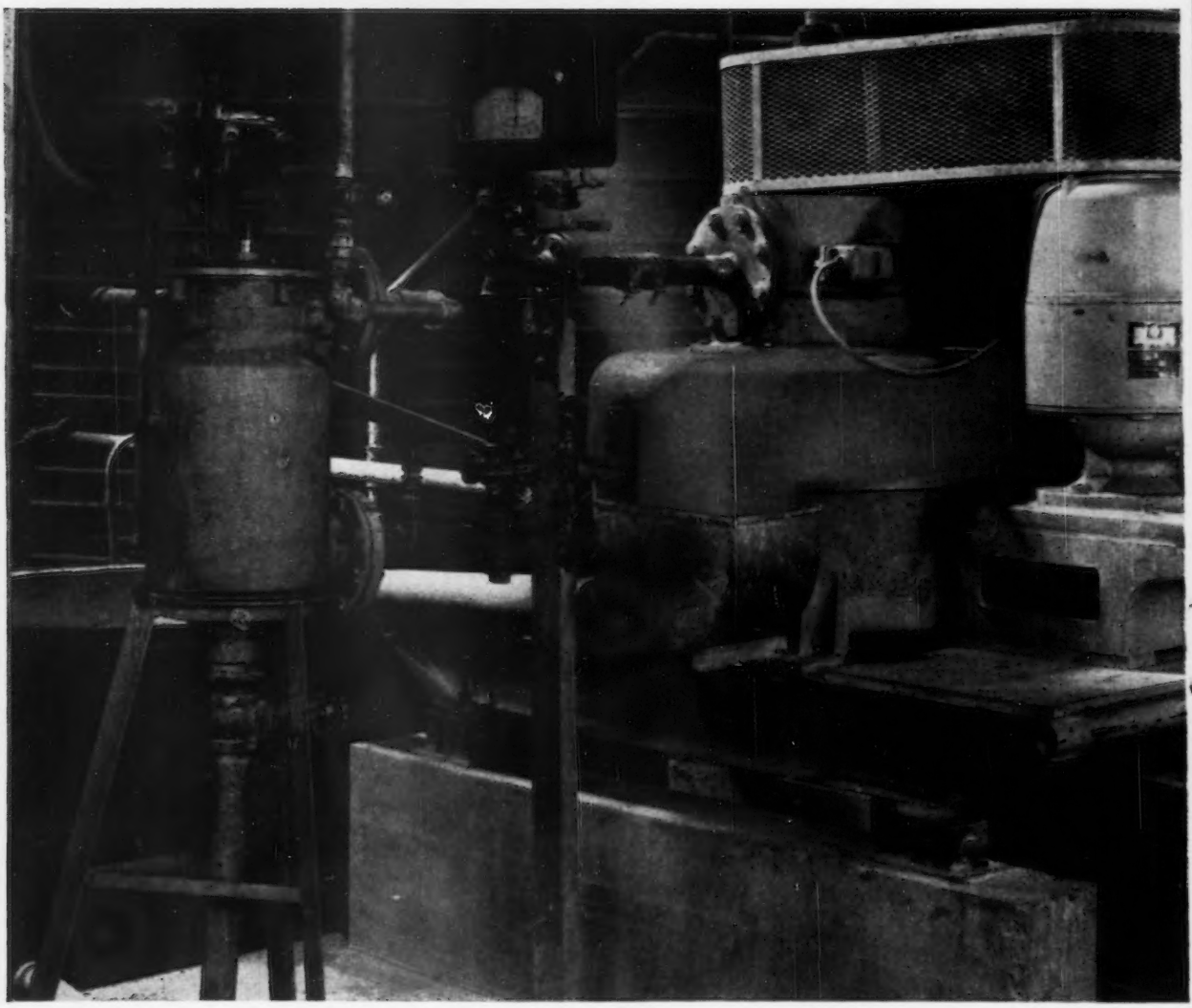
(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)



Merco Centrifugal Classification of Micron Size Particles

In the production of extra fine grade bentonite clay . . . a large mid-western chemical company makes skillful use of the effectiveness of Merco Centrifugal Separators in classifying micron size particles.

In this beneficiation process, the clay, after a primary rough cut, is fed to a Merco A-24 Centrifugal Separator for secondary classification.



Final cut is made in a high speed Merco Model C-30 Centrifuge which produces the consistently high quality end product.

The Merco Centrifuge, incorporating the unique return flow principle, can continuously handle the 5 basic separations . . . concentration, clarification, washing, soluble recovery and classification . . . on a 24 hour a day, 7 day a week basis.

For more details on the complete line of Merco Strainers, Centrifuges and Screening Centrifuges, just drop a line to Dorr-Oliver Incorporated, Stamford, Connecticut.

Merco — T.M. Reg. U. S. Pat. Off.

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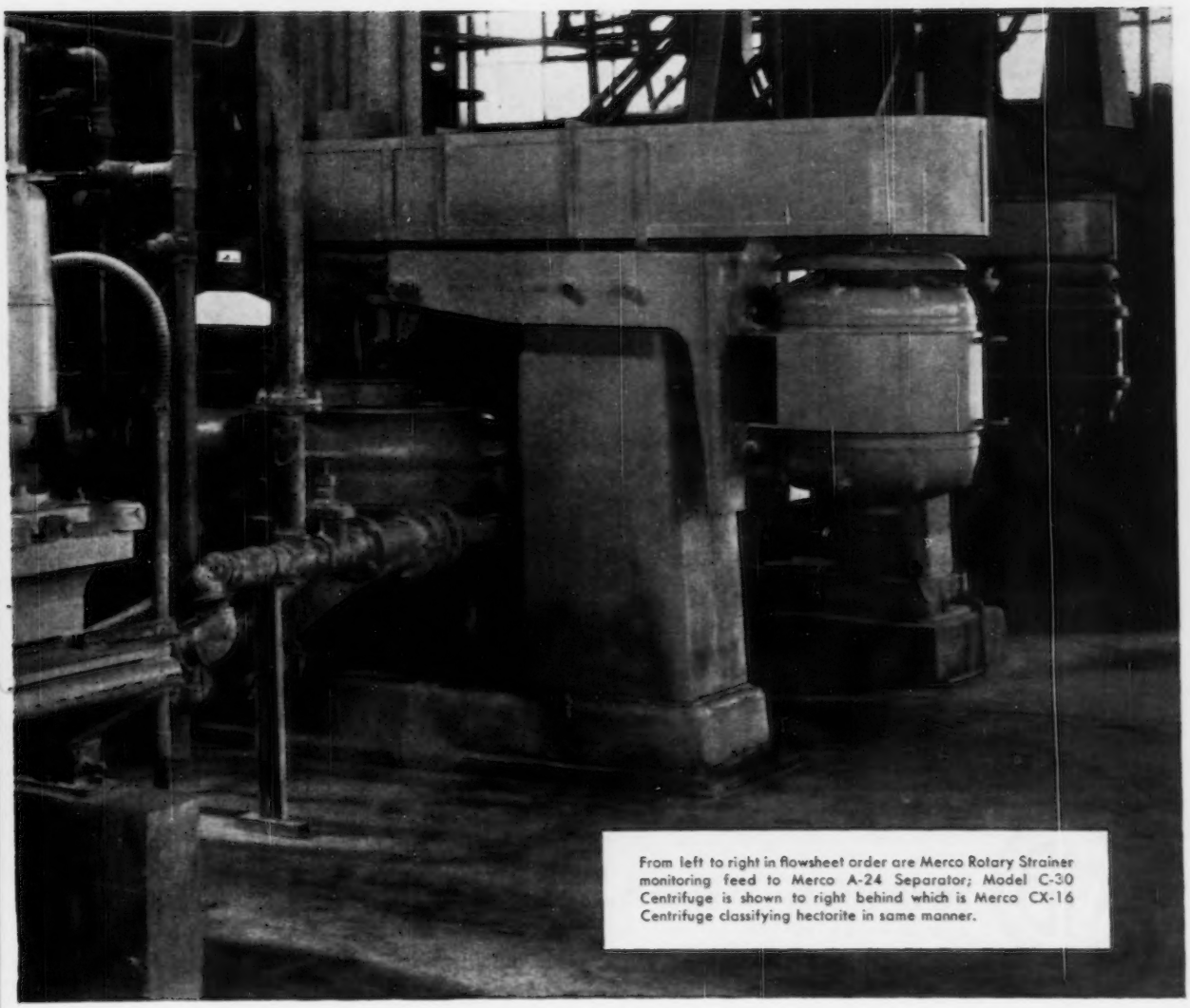

From left to right in flowsheet order are Merco Rotary Strainer monitoring feed to Merco A-24 Separator; Model C-30 Centrifuge is shown to right behind which is Merco CX-16 Centrifuge classifying hectorite in same manner.

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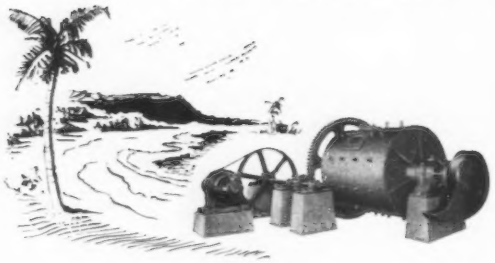
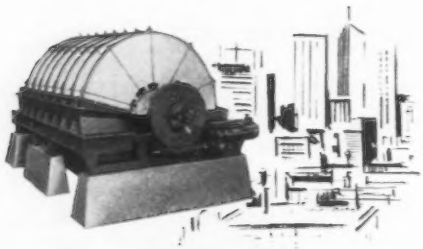
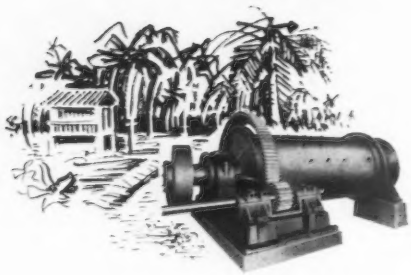
MORSE BROS. MACHINERY **CO.**
ESTABLISHED 1898



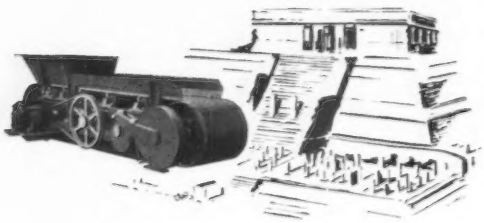
MORSE BALL MILLS point the way to new efficiency and economy of operation. Made in 30-inch, 3-foot and 4-foot diameters, their wave type head and shell liners are crafted of hard-iron, molychrome or manganese steel. The large diameter heavy construction trunnion bearings are self-aligning. The 3-foot and 4-foot mills have three-bearing countershafts with sole-plates for lateral adjustment of gears. Scoop or combination drum and scoop feeders available. Bulletin #D-575 tells all about our world-famous ball mills.



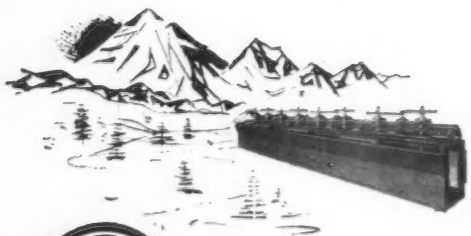
MORSE "CONTINUOUS" DISC FILTERS are part of the industrial heart of Pittsburgh. Preferred over other types because they require less floor space per ton of material treated, they can filter concentrates of different materials simultaneously. Sizes range from 4-foot, one disc filters, to 8-foot, eight disc filters, offering as little as 22, or as much as 800 square feet of filter area to handle a wide latitude of assignments. For particulars, write for Bulletin #D-5710.



MORSE ROD MILLS, wherever they're in use, offer low power costs per ton of ore ground, with maximum working efficiency. Manufactured in sizes of 3-foot and 4-foot diameters, up to 11 feet in length. They are the practical choice for grinding coarse feeds up to 65 mesh. Years of dependable service have proven their worth in service around the world. For full details, including capacity and grinding rod data, write for our Bulletin #D-575.



MORSE SILENT "VARI-STROKE" ORE FEEDERS combine flexible capacity with dependable performance, silent operation and simple regulation. They excel for feeding dry or wet crushed ore in uniform and pre-determined quantities from ore bins to grinding machinery. Belt speeds vary from 0 inch to 7 feet per minute with movement precisely controlled at all times. Request Bulletin #D-579.



MORSE "JETAIR" FLOTATION CELLS employ new and unique principles of aeration and agitation to make them universally acceptable for metallurgical efficiency and mechanical dependability. They're available in a wide range of sizes from 7 to 700 cubic feet per cell. Each individual cell has its own weir gate pulp level control. For detailed information, write for Bulletin #D-572.

MORSE BROS. MACHINERY CO.

A reliable source for all metallic and non-metallic ore dressing plants. Send us your flow sheet for prompt quotation.

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Get a complete profit picture with new, free Blasting Cost Chart! Let the Atlas Man show you how

Explosives costs alone don't always determine value of a blast. The explosives used have a direct effect on drilling, digging, hauling and crushing costs. Now, a free, simplified computing method—developed by Atlas, gives you a true, complete cost analysis of profits, without involved bookkeeping.

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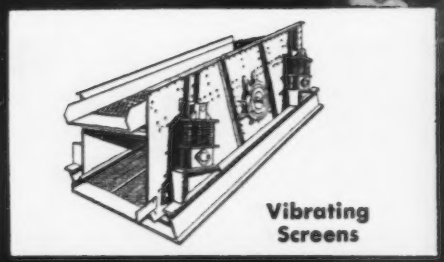
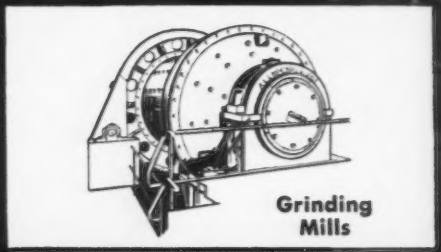
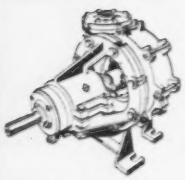


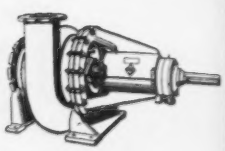
Vibrating Screens



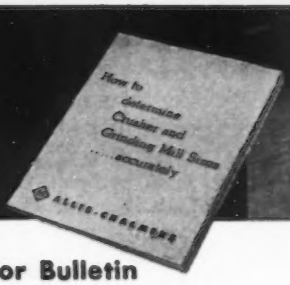
Grinding Mills



Rubber-Lined Pumps



Solids Handling Pumps



Send for Bulletin 07R7995

"Work index" formula enables you to evaluate crushing and grinding operations . . . compare efficiency of plants, circuits, machines. This handy reference offers only scientific method of determining the right machine and required horsepower.

Gyratory Crushers

Emergency unloading, wear compensation, setting changer are flip-of-the-switch operations on Allis-Chalmers crushers equipped with *Hydroset* mechanism. Even the world's largest crusher utilizes the convenience and economy of the *Hydroset* mechanism.

Texrope Drives

For maximum efficiency in transmitting power between motor and machine, Allis-Chalmers offers a complete line of *Texrope* V-belt drive equipment . . . variable speed sheaves, fast adjusting motor bases, *Texrope* belts with 33% more gripping strength.

GET ALL THE FACTS. See your Allis-Chalmers representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-

One Responsibility

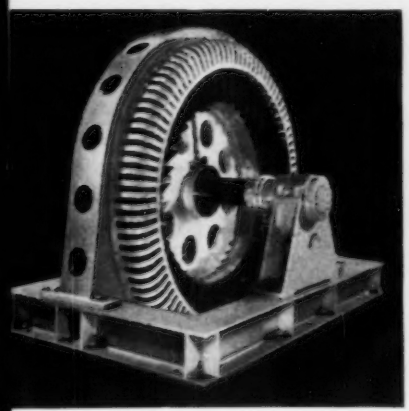
PROFIT PACKAGE

Processing Machinery, Pumps, Motors and Power Equipment Engineered to Work Together . . . Designed to HELP YOU Increase Production and Cut Costs

CRUSHERS, grinding mills, screens, pumps, generators, switchgear, transformers, motors, drives, control — *Allis-Chalmers builds them all.* And out of this unequalled diversity has come the unique ability to "coordineer" machinery and equipment for a complete process—yes, even for an entire plant.

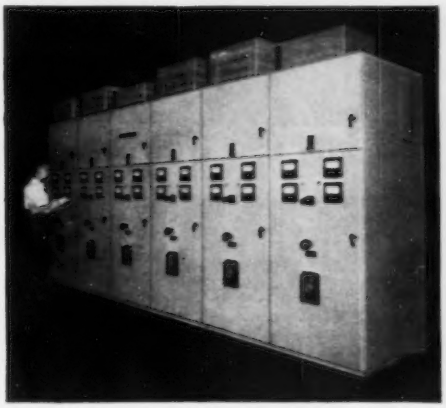
How it Works

Allis-Chalmers maintains separate departments staffed by research, design, manufacturing and application specialists for each product. "Coordineering" results from an interdepartmental exchange of ideas and technical information correlated in *one department specializing in mining applications.* In this department components are matched to meet the requirements of your job. New as well as existing equipment in your plant is integrated into a smooth, productive, profitable operation. And, of course, Allis-Chalmers assumes undivided responsibility for efficient performance.



Motors

Allis-Chalmers builds a complete line of motors from ½ horsepower and up. Applying the "work index" formula, Allis-Chalmers engineers can help you determine the required power input and apply the right size motor needed for maximum efficiency and economy.



Control

Starter illustrated features circuit designed to cut crusher downtime. Overload protection is provided by two sets of thermal overload relays. One set operates on slight overload to sound warning. Second set stops motor when temperature reaches the danger point.

Unit Substations

Designed for maximum flexibility. Additions or replacements to basic centralized unit can be made conveniently at any time. Strategically located, unit substations bring high voltages near load centers — cut cable costs, minimize line loss, save space, provide complete protection.

CHALMERS

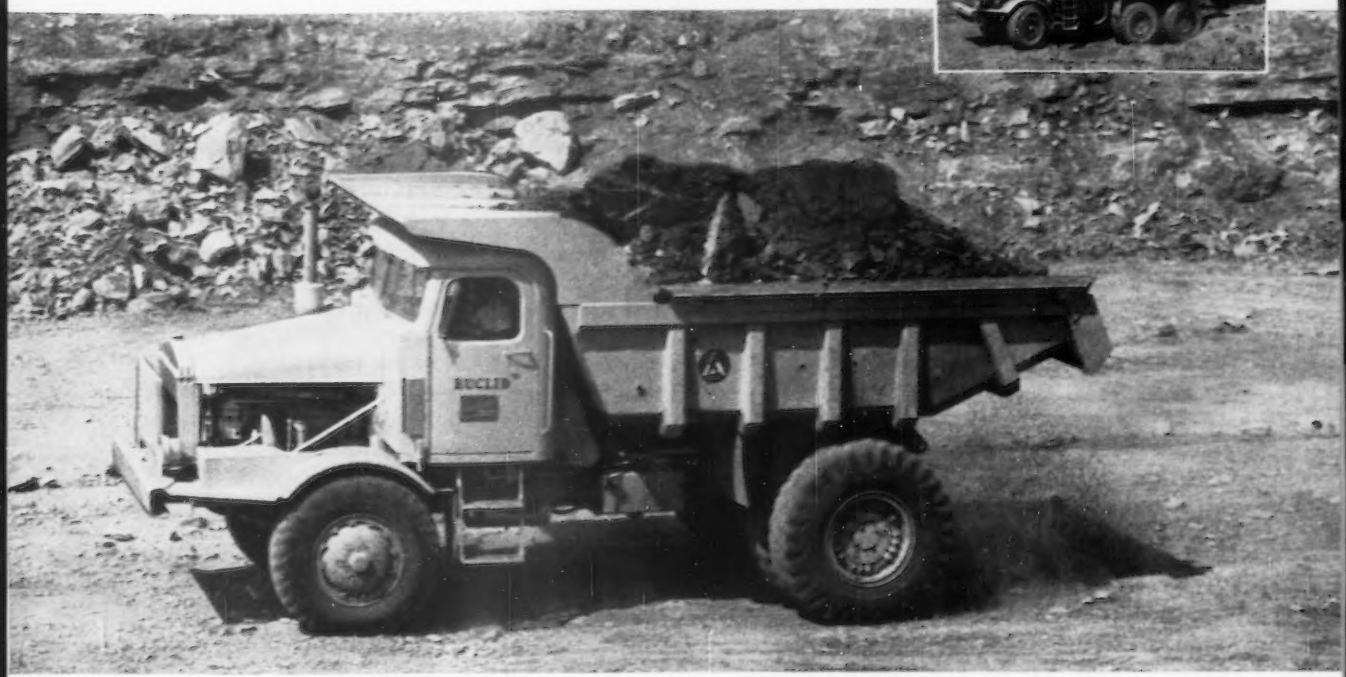
A-C ALLIS-CHALMERS

Hydroset and Texrope are Allis-Chalmers trademarks.

A-5406

It's a fact . . .

"EUC" REAR-DUMPS HAUL AT LOWEST COST!



Here's Why . . .

For 25 years Euclid Rear-Dumps have been the outstanding choice of contractors, mines and quarries. They outnumber competitive off-highway haulers by close to a 4 to 1 margin. This unequalled field experience, backed by continuous product improvement, results in operating and maintenance advantages that enable "Eucs" to haul at lowest cost. These bonus benefits are not always apparent — seldom are, in fact — when you simply compare specifications, but they're mighty important to owners.

Tops in Availability

Downtime records invariably show that "Eucs" have unusually high availability and require a minimum amount of service and repair. This ability to stay on the job cuts costs, too, in standby equipment and in maintenance personnel and facilities.

Parts and Service Unequalled

With a large machine population, dealers can logically provide complete parts stocks and service but with a small number of machines in an area, extensive parts and service facilities are not economical. Generally, parts and service are available to owners of equipment in close relation to the number of machines in the territory. On this score—which has a direct bearing on the production and hauling costs of equipment—the Euclid dealer is your best source for Rear-Dump haulers, because his larger machine population justifies complete service and parts stocks to keep the equipment producing at lowest cost.

You can depend on "Eucs" and your Euclid dealer for everything that contributes to lowest cost hauling. That's why ***Euclids are your best investment.***

EUCLID DIVISION GENERAL MOTORS CORPORATION, Cleveland 17, Ohio

GM GENERAL MOTORS EUCLID

EUCLID EQUIPMENT

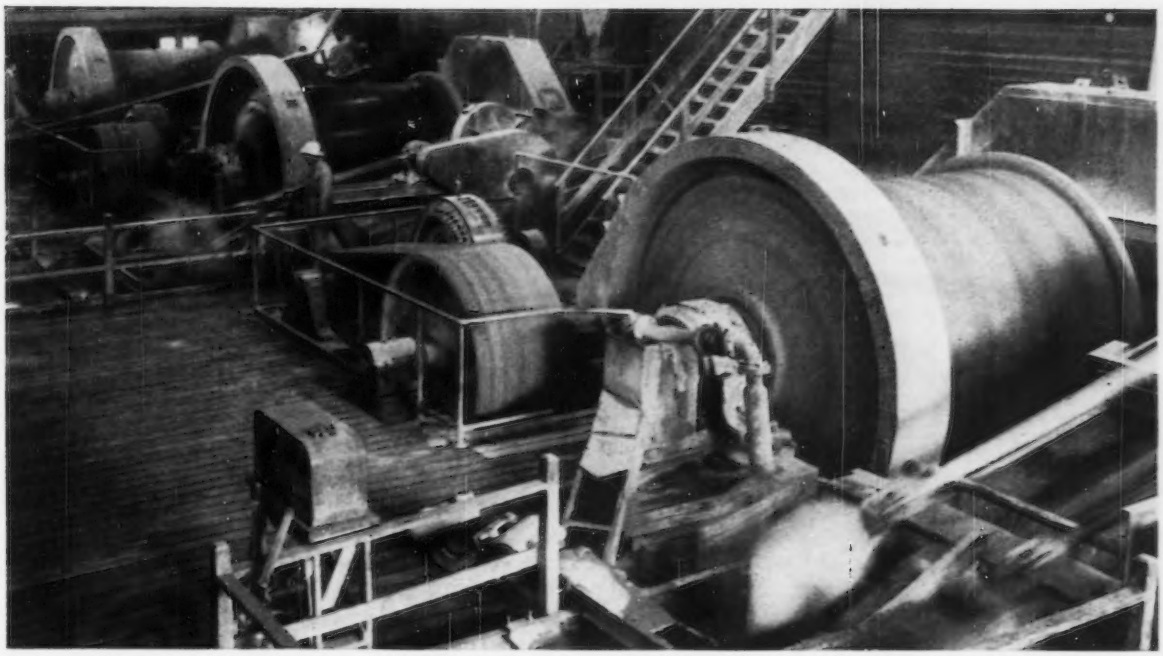
FOR MOVING EARTH, ROCK, COAL AND ORE

ENGINEER'S FIELD REPORT

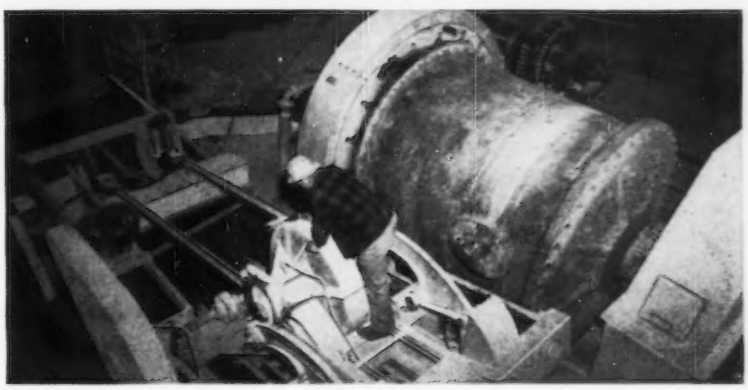
PRODUCT CHEVRON GEAR COMPOUND

FIRM BAGDAD COPPER CORP.
Bagdad, Arizona

Not one gear failure using Chevron Gear Compound



During 5 years that Bagdad Copper Corp. has used Chevron Gear Compound (formerly Calol) in its ore concentrator mill, not a single gear has broken down, required repair or replacement as a result of lubricant failure. Despite continuous operation and extreme pressure, gear teeth show no scuffing or galling. Mill moves some 4,000 tons of ore through its four ball mills and classifiers every 24 hours.



Enclosed gears of firm's four Western Machinery classifiers are lubricated with Chevron Gear Compound. Copper ore is pulverized in ball mills by tumbling with 32 tons of 3" steel balls. Classifiers then screen out oversize pieces for return to ball mills. Reduction gear box which Master Mechanic Al Smith is inspecting (above) powers connecting arms which agitate mixture of pulverized ore and water in classifier.

Why Chevron Gear Compound protects enclosed gears

- Tough film protects gear teeth against scuffing and scoring under severe shock, load conditions.
- Highly adhesive...clings to gear teeth and bearings, even under wet operating conditions.
- Oiliness additive reduces friction

For More Information on this product contact your nearest representative, or write direct to any company listed.

CHEVRON Industrial Lubricants

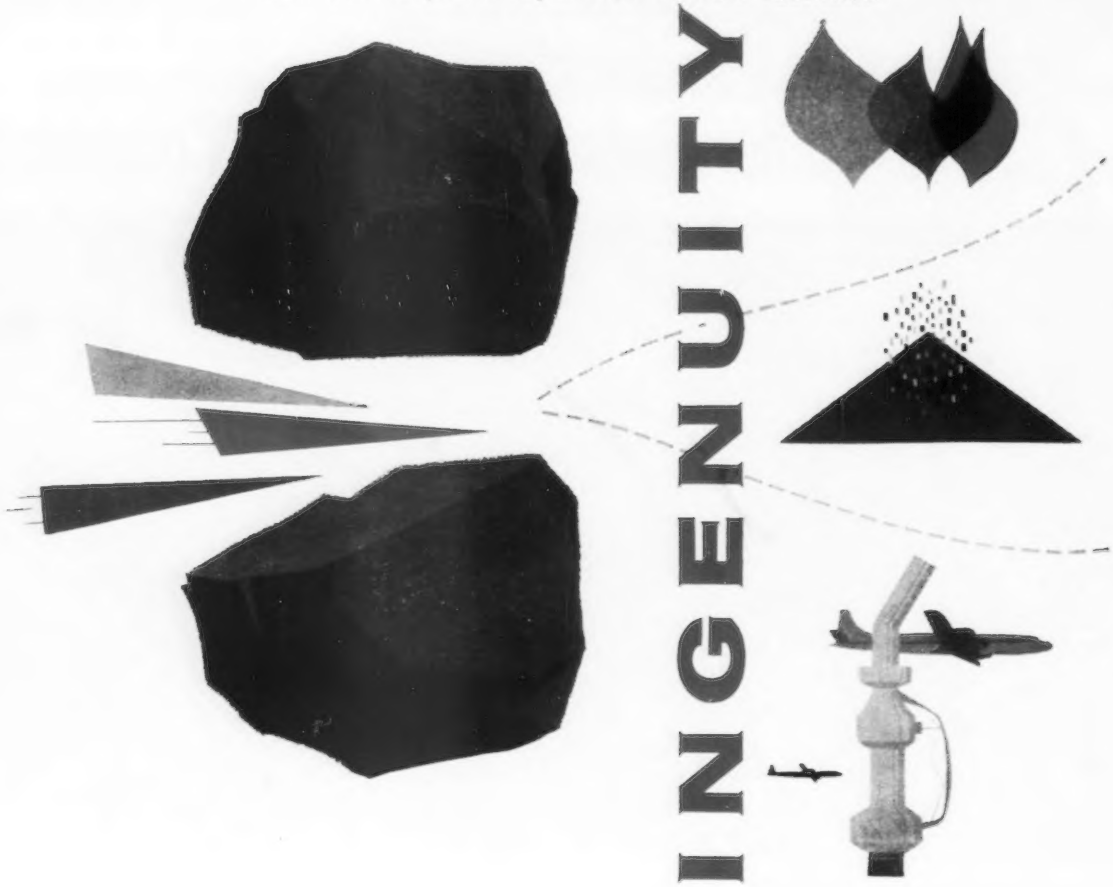
TRADEMARKS "CHEVRON" AND "CHEVRON" DESIGN REG. U.S. PAT. OFF.

STANDARD OIL COMPANY OF CALIFORNIA,
225 Bush Street • San Francisco 20, California

THE CALIFORNIA COMPANY,
P. O. Box 780 • Denver 1, Colorado

STANDARD OIL COMPANY OF TEXAS
P. O. Box 862 • El Paso, Texas

call KE for plant expansion or new facilities



has made KE a major engineer-contractor serving Minerals and Petroleum

Nation's pioneer major commercial Gilsonite refinery near Grand Junction, Colorado... Another example of KE ingenuity.

Ingenuity at work—at American Gilsonite, Kaiser Engineers designed and built an enclosed, controlled-atmosphere calciner with associated power and plant equipment making possible 100% utilization of raw Gilsonite. First major all-commercial Gilsonite refinery built, the new plant produces 99.50% pure coke, extreme purity gasoline, and uses gaseous residue to power the entire facility.

From economic analysis through start-up, KE builds ferrous, non-ferrous, industrial minerals and petroleum processing plants; brings valued experience to every phase from mining and beneficiation to transportation and materials handling.

Let KE ingenuity save time and money for you. With your first thought of new facilities or expansion, call KE.

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MARKETS

ENGINEERING AND MINING JOURNAL

APRIL 1958

Our Special Space Problem— Conquest of the Infinitesimal

NOW THAT IT'S THE VOGUE to talk about space, missiles and orbiting man-made planets, it might be well to remind ourselves that, as mining men, we have a special type of space to conquer.

This type concerns itself with our economic survival and is not the infinite space of the universe. On the contrary, this special space lies in the infinitesimal universe of the atom.

All matter is essentially space. In fact, scientists tell us that if the entire mass of a human body were compacted into one particle, that particle would be a speck just barely visible with a powerful hand lens. What really gives matter the bulk that we observe it to have is the motion of electrons in multiple orbits about the nucleii of atoms, and the electromagnetic forces which at once hold apart and still hold together the infinitesimal bits of matter that make up the solids, liquids and gases which we can see, feel or sense.

Fortunately the behavior of orbiting electrons conforms to very definite laws which man has learned to understand quite well during the past century. Man can speed up these electrons, slow them down, knock them out of one orbit into another, push them around, or even pry them loose—and in so doing bring about the vast number of linkages or separations between atoms or combinations of atoms that constitute the basis for many of our metal and mineral extractive processes today.

But one fact remains quite clear.—We have only begun to adapt the laws of the electron, and its affiliate, the ion. The rash of new mineral processes showing up in patent offices all over the world is sufficient evidence of this fact. The pages of this journal and other technical literature have carried an unprecedented number of articles on new and even revolutionary extractive processes and techniques during the past few years.

If we regard these new processes as *simply* processes, we may become confused and find it difficult to understand them, or to evaluate them for practical adaptation. However, if we will recognize one aspect common to all of these new developments, we may find it somewhat easier to orient ourselves in the fast-changing field of mineral processing. That common denominator is the behavior of the ion and the electron. If we will analyze all of these new high sounding techniques such as chelation, ion exchange, solvent extraction, direct reduction, etc., in light of the laws of the electron and the ion, we will find that they are fairly easy to understand.

So we have all got to go back to the ion and the electron. For this reason, the article which starts on p 85 carries a prelude which takes us back to the fundamental structure of the atom, the periodic table which classifies the structure of matter, and a number of basic laws which govern the behavior of the electron and the ion.

A return to these fundamentals can help us in a number of ways. First it can simplify our understanding of the many new processes now under development. Second, it can help us evaluate them for possible adaptation to our mill and smelter flowsheets. And finally, it can help us determine whether we are using the laws of the ion and electron as effectively as possible in our mineral processing.

The deluge of new mineral processing techniques which now besets us did not just happen. It was pressured into existence by the expanding needs of the industrial world for metals and minerals. Having dipped deeply into the reserves of rich ore deposits, the mining industry must now turn to those deposits which heretofore have defied economic extraction such as the taconites, and the integrally intermixed base-metal ores now being explored in the U. S., Canada, South America and elsewhere. Many of these ores defy physical separation by flotation, gravity or magnetic methods. The only recourse will be to take the metals into solution. Then, how we chase them around in the metallurgical circuits, and finally corral them into separate pens will depend upon how well we understand the ion and the electron, and how well we are able to make the laws of ion exchange and electron transfer work for us.

MARKETS

Aluminum Prices Cut 2c; Lead Cut 1c; Copper Firmer; Zinc Stockpiling Ends

MARCH NONFERROUS METAL PRICES dropped to 167.31% of the 1922-'24 average from 168.38 in February. The drop in the monthly copper average brought it down.

Copper prices in Europe rose in March. Prices of custom smelters and dealers in the U. S. rose; brass and bronze ingot prices went up.

Katanga was at 20.245c per lb at main European ports and N. Y. at the beginning of March; it raised several times and on the 28th it reached 22.675c. The London Metal Exchange was £161¼ cash bid March 3; on March 31 it was £178¾. This is a rise of about 2c, to about 22¼c. The premium for wire bars in London was about 1½c.

The price strength in Europe was much debated. Many observers attributed it largely to speculators on the LME and the N. Y. Commodity Exchange. It was suggested the belief had been developed among many persons who are not active in the metal industries that copper had hit bottom and that it must go up. These people then bought copper contracts. Doubtless this was an element and pushed the LME and CX up. But other matters were also important. Some producers have been turning down requests for copper—certainly they have declined to do business at LME prices. In spite of the high stocks of refined copper held by producers outside the U. S. (and in the U. S.), doubtless some have little copper for nearby shipment. And some sellers have been doing very little business for nearby delivery. Much of the spot and nearby business is done by merchants and custom smelters and they have much less copper now than formerly. The reduced amount resulted from 1) the low prices brought out less scrap 2) the lower output of copper by mines that supply concentrates to smelters or which turn over their copper to merchants and 3) the drop in resale copper by fabricators (their inclination to sell has declined; also, producers have been more effective in convincing them they should not resell). The supply of "floating" copper in the U. S. is lower for these reasons plus the lower scrap generation resulting from sharply reduced fabricator activity.

Custom smelters in the U. S. sold heavily in the second and third weeks of the month. In the last week business dropped off greatly. Sales dropped off many analysts say because fabricators bought all they need for a month—they suggest it was a matter of accelerated buying rather than the need for more copper to meet the demand for copper products.

Smelters raised prices after they sold heavily. They went to 23½c and a few days later to 24c. The heavy sales stopped but few attribute it to the price increase.

Copper statistics were depressing. World deliveries dropped 35,702 tons in February and stocks of refined copper rose 21,564 tons. The new stock figure was 470,464 tons—the monthly average 1953-1956 was about 261,000 tons. Copper fabricator statistics for the U. S. were disappointing. Their stocks of copper in products and refined rose about 7,000 tons to 452,673 tons and shipments dropped 8,000 from the revised January figure of 94,642 tons. Sales rose 11,500 tons to 91,199.

The 4c copper import tax bill, S-2998 and H.R. 10074, has an improved chance of passing, some observers believe. Now apparently all U. S. copper mining firms are in support of it including those with large wholly-owned mines outside the U. S.

Aluminum prices were reduced about 2c effective April 1 by Alcan. The U. S. producers followed. This is the first price drop for primary aluminum since Alcoa put the price down to 15c a lb from 17c for ingot Oct. 1, 1941.

Reasons for the cut are widely debated. Alcan had asked the British Board of Trade to place an anti-dumping import duty against Russian aluminum; the Board has not acted on the request. The U. K. has been a major market for Alcan's aluminum. The price reduction could indicate to the Board of Trade that Alcan is willing to make concessions. Its new price in the U. K. is £180 per long ton c.i.f. ports. It had been at £197 with a discount of 2% for most customers. The USSR and other European producers have been selling at lower prices—the USSR metal has been under Alcan's new price. Some fabricators feel that Alcan is the lowest cost producer and this price drop will squeeze out the higher cost plants of some of the U. S. producers. They suggest it strengthens the Alcan competitive position. But Alcan depends on raw metal while most of the others sell much fabricated product (Kaiser less than the others) so if they do not drop fabricated product prices much they will not lose so much revenue. Many fabricated product prices were unofficially cut about 2c early this year.

Spain was offered about 3,000 long tons on a tender on March 27 at the following f.o.b. prices: Kaiser 21.48c, Alcan 21.4c, Alcoa 25c. Austrian and Norwegian sellers were in between and Pechiney was a little under Alcoa.

Zinc stockpiling has ended. ODM director Gordon Gray said March 31 the contracts made in March ended the program (*Metal and Mineral Markets*, Mar. 6, 1958, p 1). Sales in March to GSA were reduced from previous months. Sales made to industry were also exceptionally low though possibly a little above February.

National Zinc and Asarco cut output. Zinc shipments reported by the American Zinc Institute fell in February.

1957 GSA Copper Acceptances

Name	Tons	Value ($)	Av. Price ¢/lb.
American Metals..	4,400	2,469,401	28.1
Appalachian Sulphides.....	1,150	708,900	30.8
Banner Mining....	1,585	933,636	29.5
British Metal Corp.	6,826	4,174,245	30.6
Calumet and Hecla	21,922	13,860,070	31.6
Consolidated Coppermines....	455	292,765	31.8
Consolidated Coppermines....	600	384,038	32.0
Copper Range.....	847	531,988	31.4
Granby Consolidated.....	750	448,795	29.9
Howe Sound.....	64	41,757	32.4
International Minerals and Metals.	400	238,893	29.9
International Nickel	500	355,756	35.0
International Nickel	9,806	6,229,664	31.8
National Lead.....	265	196,240	36.9
Rhodesia Congo Power.....	5,433	3,315,533	30.5
San Manuel Copper.....12,800		6,777,791	26.5
Sherritt Gordon...	2,868	1,864,352	32.5
	70,671	42,823,824	

This total is less than the shipment figure of about 87,000 short tons previously published here because of a delay of often two months for delivery, testing and arrangements for payment. The last two months of 1957 shipments increased greatly (especially in the Copper Range contract) and most of this copper did not get accepted in time to be included in the above figures. They were introduced into the Senate hearings on mineral policy by the Senate subcommittee on mining.

Stocks rose about 9,000 tons. Shipments of Prime Western zinc dropped to 29,352 short tons—this was the lowest since July 1956 and was about 8,000 tons below January 1958. Shipments of Special High were down from January and were also the lowest since July 1956.

Lead was dropped 1c to 12c NY, Apr. 1, by a major custom smelter. Others followed. Smelters had been accumulating concentrates bought on the 13c basis.

Lead sales this month were very low and may be as low as in February. Lead stocks according to the American Bureau of Metal Statistics jumped to 119,522 tons, about 19,000 tons, in February. They were the highest since July 1939. Shipments dropped about 9,000 tons. Shipments to the Government were about 4,985, little changed from January.

ODM director Gray, who said zinc stockpile purchases had stopped, early in the month indicated lead would not be far behind zinc in this and would certainly end by June.

Nickel output is being cut 10% by Inco. Its other metals are being cut by the same amount. Rumors persist that it will cut the price of nickel from the present 74c a lb.

Tin prices have been maintained near £730 by the Tin Council. Some factors say the Council is not in a strong position—that some producing countries are not satisfied with their quotas. A Russian spokesman in Malaya denounced the Tin Council. He also told an E&MJ correspondent the USSR exported only about 5,000 tons to Europe.

Average Prices March *(E&MJ Quotations)*

Copper:	
Electrolytic, domestic refinery	24.018
Electrolytic, export refinery	20.738
Lead:	
Common, New York	13.000
Common, St. Louis	12.800
Silver and sterling exchange:	
Silver, New York, per oz.	88.625
Silver, London, pence per oz.	76.429
Sterling Exchange	281.540
Zinc:	
Prime Western, East St. Louis	10.000
Prime, Western, delivered (g)	10.500
Tin:	
New York Straits	93.514
Gold per oz. U. S. price	$35.000
Quicksilver, per flask	$231.692
Antimony, (EM&J) (d)	32.590
Antimony, bulk, Laredo	29.000
Antimony, in cases, Laredo	29.500
Platinum, refined, per oz.	$72.154
Cadmium (a)	155.000
Cadmium (b)	155.000
Cadmium (c)	155.000
Aluminum, 99% plus ingot	28.100
Magnesium, ingot	35.250
Nickel (f)	74.000

Domestic quotations, unless otherwise stated, are in cents per pound. Sterling exchange checks, in cents. Quicksilver, per flask of 76 lb.

(a) Cadmium average based on the producers quotations.

(b) Cadmium average based on the average of the producers' and platers' quotations.

(c) Cadmium average based on platers' quotations.

(d) Domestic 5 tons or more but less than carload lots, packed in case f.o.b. New York.

(f) Contract price, f.o.b. Port Colborne U.S. duty included.

(g) Delivered where freight exceeds 0.5c.

"Free" Gold Market

Volume rose 19%. Bar prices were stronger with London showing a post-war high. Coin prices remained irregular. Soviet sales, totaling 10-15 tons, were reported. Hoarding increased outside the U. S. and Soviet orbit. Some signs of gold withdrawals from the U. S. were evident. Demand for gold in Near Eastern markets rose with prices reaching a high in Saudi Arabia. India again listed the world's highest price for gold coins, $59.50 per oz. Pick's World Currency Report quotes on "free gold" per fine oz as follows:

	COINS		BARS (12.5 kg)	
	Feb. 28	Mar. 31	Feb. 28	Mar. 31
NEW YORK, transit	....	....	$35.08⅛	$35.08⅛
MANILA	$43.00	$42.00	36.30	36.20
HONG KONG	47.50	46.80	38.75	38.65
BOMBAY	57.75	59.50	57.00	58.50
TANGIER	42.65	41.25	35.10	35.20
BEIRUT	41.50	41.85	35.21	35.23
PARIS	40.45	41.50	36.40	36.30
BUENOS AIRES	37.75	37.90	36.05	35.85

Note: Prices are quoted at the free or black market value of the U. S. dollar in the local markets.

Custom Smelter Copper Price

Based on flat price and E&MJ-average price sales in U. S. for month of March reported by American Smelting & Refining Co.: electrolytic copper in standard shapes, adjusted to nearest ⅛c; ¼c deducted for selling commission.

Delivered Consumers' plant.	22.875c lb
F.o.b. refinery	22.475c lb

Major Metals

U. S. DAILY AND AVERAGE PRICES

Mar. 1958	Electrolytic Copper (a) Domestic	(b) Export	Lead New York	Lead St. Louis	Zinc (f) Delivered	Zinc East St. Louis	Aluminum Primary Pig 99%	Straits Tin New York
1	No Market	19.375	13.000	12.800	10.500	10.000	26.000	94.500
3	24.325	19.875	13.000	12.800	10.500	10.000	26.000	94.750
4	24.175	19.875	13.000	12.800	10.500	10.000	26.000	94.625
5	24.425	20.350	13.000	12.800	10.500	10.000	26.000	95.125
6	23.525	20.125	13.000	12.800	10.500	10.000	26.000	95.750
7	23.900	20.500	13.000	12.800	10.500	10.000	26.000	96.375
8	No Market	20.500	13.000	12.800	10.500	10.000	26.000	96.375
10	23.950	20.375	13.000	12.800	10.500	10.000	26.000	95.875
11	23.725	20.050	13.000	12.800	10.500	10.000	26.000	95.625
12	23.825	20.475	13.000	12.800	10.500	10.000	26.000	95.125
13	23.675	20.350	13.000	12.800	10.500	10.000	26.000	94.875
14	23.700	20.250	13.000	12.800	10.500	10.000	26.000	95.000
15	No Market	20.250	13.000	12.800	10.500	10.000	26.000	95.000
17	23.575	20.600	13.000	12.800	10.500	10.000	26.000	94.750
18	23.550	20.850	13.000	12.800	10.500	10.000	26.000	94.500
19	23.650	20.925	13.000	12.800	10.500	10.000	26.000	93.625
20	23.850	20.900	13.000	12.800	10.500	10.000	26.000	93.625
21	24.300	21.200	13.000	12.800	10.500	10.000	26.000	93.875
22	No Market	21.200	13.000	12.800	10.500	10.000	26.000	93.875
24	24.125	21.300	13.000	12.800	10.500	10.000	26.000	93.875
25	24.225	21.825	13.000	12.800	10.500	10.000	26.000	93.625
26	24.350	21.725	13.000	12.800	10.500	10.000	26.000	93.500
27	24.550	21.600	13.000	12.800	10.500	10.000	26.000	93.500
28	24.500	21.575	13.000	12.800	10.500	10.000	26.000	93.250
29	No Market	21.575	13.000	12.800	10.500	10.000	26.000	93.250
31	24.475	21.575	13.000	12.800	10.500	10.000	26.000	93.125
AVERAGES FOR MONTH								
Mar.	24.018	20.738	13.000	12.800	10.500	10.000	26.000	94.514
AVERAGES FOR WEEK								
Mar. 5	24.290	19.704	13.000	12.800	10.500	10.000	26.000	94.688
12	23.785	20.338	13.000	12.800	10.500	10.000	26.000	95.854
19	23.630	20.538	13.000	12.800	10.500	10.000	26.000	94.625
26	24.170	21.358	13.000	12.800	10.500	10.000	26.000	93.729
CALENDAR WEEK AVERAGES								
Mar. 1	24.235	19.617	13.000	12.800	10.500	10.000	26.000	94.750
8	24.070	20.204	13.000	12.800	10.500	10.000	26.000	95.500
15	23.775	20.292	13.000	12.800	10.500	10.000	26.000	95.250
22	23.785	20.946	13.000	12.800	10.500	10.000	26.000	94.042
31	24.350	21.600	13.000	12.800	10.500	10.000	26.000	93.500

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis. All prices, except gold and silver, are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.400c per pound, the average differential for delivery charges.

(b) Our export quotations for copper reflect prices obtaining in the open market and are based on sales in the foreign market reduced to the f.o.b. refinery equivalent, Atlantic seaboard. On f.a.s. transactions we deduct 0.125c for lighterage, etc., to arrive at the f.o.b. refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingots; cathodes are sold at a discount of 0.125c to 0.15c per pound. Quotations for zinc are based on Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East, Middle West, and West effective Jan. 1, 1951, commanded a premium of 1.35c per pound over the current market for Prime Western; Special High Grade 1.75c effective Dec. 1, 1955.

(f) Prime Western delivered where freight from E. St. Louis exceeds one-half cent.

Quotations for lead are based on domestic common lead. Corroding lead commands a premium of 10 pounds.

(c) The daily silver quotation reported by Handy & Harman, in cents and fractions of a cent per troy ounce, is the price paid by Handy & Harman in settlement for silver contained in unrefined silver-bearing materials submitted to them for refining. It is determined on the basis of offers of bar silver .999 fine as made to Handy & Harman for nearby delivery at New York by regular suppliers in quantities sufficient to meet daily requirements, and it is usually one quarter cent below the price at which such offers are made.

The Treasury's purchase price of newly mined domestic silver is 90.5 per troy ounce 1000 fine effective July 1, 1946. London silver in pence per troy ounce, basis .999 fine.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold is at 99.75 per cent of the price quoted by the Treasury, which is equal to $34.9125.

Silver, Gold and Sterling

DAILY AND AVERAGE PRICES

Mar. 1958	Silver (c) New York	Silver London	Sterling Exchange	Gold London	Gold (d) United States
1	(e)	(e)	(e)	(e)	$35.00
3	88.625	76.625d.	281.5000	249s. 3¼d.	35.00
4	88.625	76.750d.	281.4875	249s. 3½d.	35.00
5	88.625	76.875d.	281.4687	249s. 3½d.	35.00
6	88.625	76.875d.	281.4687	249s. 5d.	35.00
7	88.625	76.875d.	281.5000	249s. 3½d.	35.00
8	(e)	(e)	(e)	(e)	35.00
10	88.625	76.875d.	281.5781	249s. 3¼d.	35.00
11	88.625	76.750d.	281.5937	249s. 2¾d.	35.00
12	88.625	76.750d.	281.5000	249s. 3d.	35.00
13	88.625	76.750d.	281.6062	249s. 3¼d.	35.00
14	88.625	76.500d.	281.5937	249s. 3d.	35.00
15	(e)	(e)	(e)	(e)	35.00
17	88.625	76.250d.	281.6062	249s. 2½d.	35.00
18	88.625	76.125d.	281.5625	249s. 2¼d.	35.00
19	88.625	76.000d.	281.5375	249s. 3¼d.	35.00
20	88.625	76.000d.	281.5187	249s. 3d.	35.00
21	88.625	76.000d.	281.3750	249s. 3¼d.	35.00
22	(e)	(e)	(e)	(e)	35.00
24	88.625	76.000d.	281.4375	249s. 4½d.	35.00
25	88.625	76.250d.	281.5937	249s. 3d.	35.00
26	88.625	76.250d.	281.6250	249s. 3½d.	35.00
27	88.625	76.250d.	281.6250	249s. 4d.	35.00
28	88.625	76.250d.	281.5937	249s. 4½d.	35.00
29	(e)	(e)	(e)	(e)	35.00
31	88.625	76.000d.	281.5625	249s. 3¼d.	35.00
AVERAGES FOR MONTH					
Mar.	88.625	76.429	281.540	—	35.00
AVERAGES FOR WEEK					
Mar. 5	88.625	—	281.391	—	35.00
12	88.625	—	281.528	—	35.00
19	88.625	—	281.581	—	35.00
26	88.625	—	281.510	—	35.00

Calendar Week Averages: New York Silver: 1st, 88.625; 8th, 88.625; 15th, 88.625; 22nd, 88.625; 29th, 88.625; 31st, 88.625.
(e) No Market (Saturday).

MARKETS (*Continued*)

London Metal Exchange Quotations

	COPPER				LEAD				ZINC				TIN			
	Cash		3 Mo.		Current Month		3 Mo.		Current Month		3 Mo.		Cash		3 Mo.	
Mar.	Bid	Asked	Bid	Asked	Bid	Asked	Bid	Asked	Bid	Asked	Bid	Asked	Bid	Asked	Bid	Asked
3	161¼	161½	163	163¼	73½	73¾	73¼	73¾	62½	62¾	62½	62¾	731	732	736½	737
4	163¼	163¾	165¼	165½	74¼	74½	73¾	74	63	63½	63¼	63¾	731	732	736	737
5	162½	162¾	164½	164¾	74¾	74⅞	74⅜	74½	63½	63¾	63¼	63½	731	732	738	739
6	166	166½	168¼	168½	75¾	74⅞	75	75¼	64	64⅛	64¼	64	734	735	740	741
7	165	165¼	167	167½	74½	74¾	74	74⅛	63	63¼	63½	63¼	736	738	742	743
10	163	163¼	165	165½	74¾	74⅞	73⅞	74	62⅞	63	62½	63	730½	731	738	741
11	165¼	165½	167½	167¾	74½	74⅝	74	74¼	63	63¼	63¼	63½	731½	732	738	739
12	166¾	167	169	169¼	74⅝	74¾	74⅜	74½	62⅞	63⅛	63¼	63½	731½	732	736	736½
13	164¾	165	167	167¼	74¼	74⅜	74⅛	74¼	62⅞	63	63¼	63½	731	731½	736	737
14	167½	168	169¼	169½	74½	74⅝	74½	74⅝	63¼	63½	63⅜	63¾	732	732½	738	739
17	169½	169¾	171¼	171½	75	75¼	74⅞	75	63¾	64	63¾	64	730½	731	736½	737
18	173	173½	171½	172	75	75⅛	74⅞	75⅛	63¾	64	63¾	64	730	730½	736	736½
19	168¼	168½	169	169¼	74¾	74⅞	74⅜	74¾	63⅜	63½	63½	63⅝	730	730½	733	734
20	174¼	174½	174¼	174½	75½	76	75¼	75½	64	64¼	64¼	64¼	730	730½	733	734
21	174	174¼	174¾	175	75¼	75½	75	75¼	63½	63¾	63⅜	63¾	730	730½	734	734½
24	178	178¼	178½	178¾	75¾	75⅞	75⅝	75¾	63¾	64	64	64¼	730	730½	733½	734
25	178	178½	178½	178¾	75½	75⅝	75⅜	75½	63⅝	63¾	63⅝	63¾	730	730½	732½	733½
26	176	176½	176¼	176½	75	75¼	74¾	75	63¾	63⅞	63¾	63⅞	730	730½	732	732
27	178	178¼	177¾	178	74⅞	75	74⅞	75	63¾	64	63⅞	64	730	730½	731	731½
28	176½	176¾	176½	176¾	73¾	73½	73½	74	63½	63¼	63	63¼	730	730½	730½	731
31	178¾	179	178¾	179	73⅝	73¾	73½	73¼	63½	64	63½	63¾	730	730½	729	730
Av'g's.	£170.137		£171.220		£74.789		£74.563		£63.488		£63.557		£731.286		£735.655	

Prices are for the official a.m. session in pounds sterling per ton of 2240 lb. Copper basis wire bars, lead 99.97%, zinc 98¼ and tin min. 99.75%.

Miscellaneous Metals, Ores, Minerals

Quotations cover wholesale lots, prompt shipments f.o.b. New York unless otherwise stated, tons of 2,000 lb. unless otherwise noted. St—short ton; lt—long ton.

MISCELLANEOUS METALS

March 31, 1958

Aluminum ingot, 99 plus %, lb.		(d)28 .1¢
Antimony, spot, lb. less than carload, in cases		32.59¢
In bulk, carload lots, f.o.b. Laredo		29.00¢
Bismuth, ton lots, lb.		$2.25
Cadmium, commercial sticks, delivered, lb.		$1.55
Calcium, lb. ton lots, 98%, cast		$2.05
Chromium, 97% grade, lb. contract del.		$1.29
Cobalt, 97 to 99%, per lb. eff. Feb. 1, 1957		$2.00
Germanium, per gram, 10,000 gram lots	(c)38¢ @	(d)45½¢
Indium, troy oz.	$1.25 @	$2.25
Lithium, lb. 98%	$11.00 @	$14.00
Nickel, cathodes, lb (a)		74¢
Other sales, reg. sellers		74¢
Sales by dealers, etc.	70¢ @	75¢
Magnesium, 99.8% carloads, lb. producer's plants, Velasco, Texas, eff. Apr. 16		35¼¢
Palladium, troy oz.	$19.00 @	$21.00
Platinum (wholesale lots), troy oz.	$69 @	$75
Quicksilver, flask of 76 lb., 25 flasks or more	$232 @	$236
Selenium, 99 plus %, lb—(Feb. 19, 1958)		$7.00
Silicon, minimum 97%, carloads, lb.		22¢
Semi-Conductor grade, lb.		$350
Tellurium, lb.		$1.65
Thallium, 100 lb. or more, lb.		$7.50
Titanium, 99.3 plus, grade A-1, max. 3% iron, lb. (e)		(b)$2.25

(a) Eff. Dec. 6, 1956; incl. U. S. duty; (b) Effective June 3, 1957. (c) Delivered; (d) f.o.b. plant. (d) 26.1 eff. Apr. 1, 1958. (e) $2.05-2.25 eff. Apr. 1, 1958.

METALLIC ORES

Beryllium Ore, imported, 10% BeO, per short ton unit	$34.00 @	$35.00
Chrome Ore per long ton, f.o.b. cars Atl. ports, dry:		
44% Cr_2O_3 no ratio	$26 @	$26.50
48% Cr_2O_3 3 to 1 ratio	$47 @	$57
Iron Ore, Lake Superior, Lower Lake ports, long ton:		
Old Range bessemer		$11.85(e)
Mesabi bessemer		$11.60(e)
Mesabi, non-bessemer		$11.45(e)
Lead (Galena), 80%, Joplin, Mo., ton (b)		$156.12
Manganese Ore—Per long ton unit of Mn basis 48% manganese, nearby positions, subject to premiums and penalties, c.i.f. U. S. ports, import duty extra, export duty included, $1.33 @ 1.36; both duties excluded, $1.195 @ $1.225. Long-term contract nominal.		
Molybdenum Ore, 90%, per lb. of Mo f.o.b. mines	$1.18 @	$1.23
Columbium-Tantalum, per lb., combined oxides 10 to 1 ratio	$1.15 @	$1.20
Tungsten Ore, per stu of WO_3:		
Foreign 60%, c.i.f. U. S. ports, duty extra	$10 @	$12.50
U. S. scheelite, f.o.b. mill	$19.50 @	$20
Vanadium Ore, per lb. of contained V_2O_5 f.o.b. mines		31¢
Zinc Ore, Prime, 60% concentrate, Joplin, Mo., per ton		$56

(a) Nominal. (b) $141.72 Apr. 1, 1958. (e) Eff. 1957 shipping season.

METALLIC COMPOUNDS

Arsenous Oxide (arsenic trioxide) lb., in bbl. carload lots delivered		5½¢
Cobalt Oxide, 72½% to 73½%, per lb. eff. Dec. 1, '56	$1.52 @	$1.55
Copper Sulphate, 100 lb eff. Jan. 13, '58		$10.70
Germanium Oxide, gram		27½¢
Molybdic trioxide, technical, per lb. of Mo	$1.38 @	$1.41
Imported, incl. 37¢ duty	$1.75 @	$2.05

ALLOYS

Ferrochrom 65 to 70%, per lb. of Cr. (4-9% C)		28¾¢
Ferromanganese, 74 to 76%, per lb., shipg. pt.		12¾¢
Ferromolybdenum, 58 to 64% Mo, lb. of Mo contained	$1.68 @	$1.74
Ferrosilicon, 50% per lb. of Si f.o.b. shipping point (3-19-57)		14.20
Ferrotungsten, 72 to 82%, lb. of W contained		$2.15
Ferrovandium, per lb. of V delivered	$3.20 @	$3.40
Silicomanganese, max. 1½% carbon, lb., contracts		12.8¢
Spiegeleisen, per long ton, 10 @ 21% grade eff. Jan. 7		$102.50

NON-METALLIC MINERALS

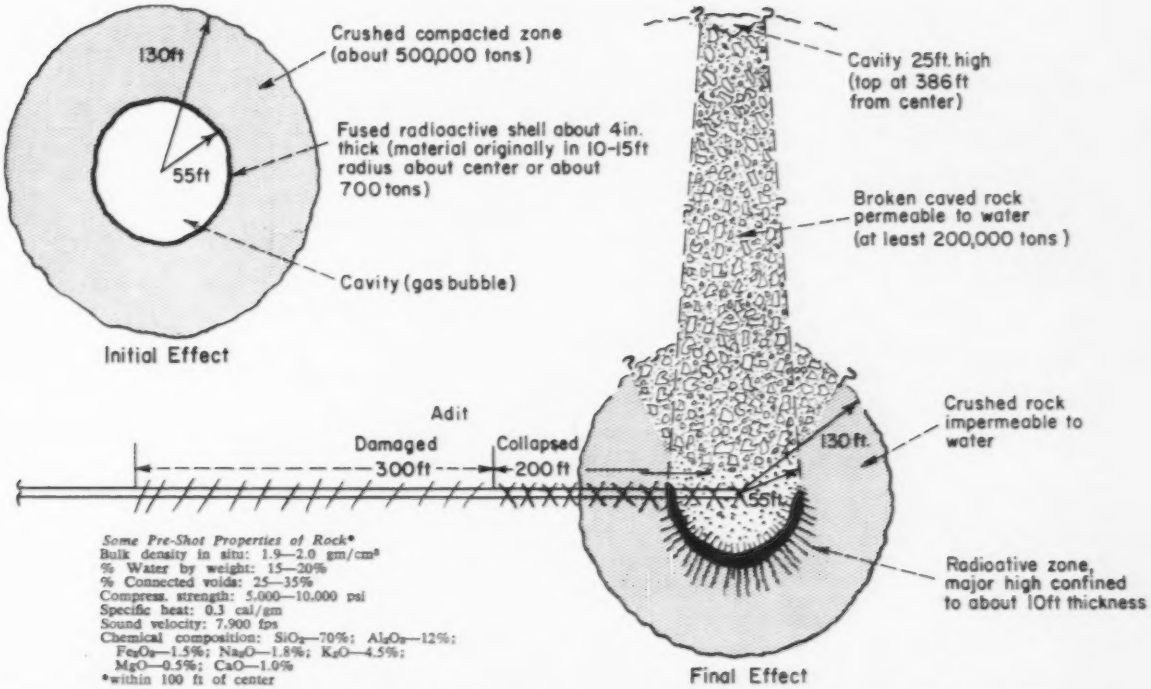
Asbestos, f.o.b. Canada (Quebec) mines (Canadian funds) ton:		
Crude No. 1	$1,470 @	$1,810
Crude No. 2	$788 @	$1,155
Spinning fibers	$353 @	$593
Shingle fibers	$190 @	$220
Paper stock	$120 @	$142
Waste	$82 @	$86
Shorts	$27 @	$75
Asbestos, f.o.b., Vancouver, B. C. (Canadian funds):		
Crude No. 1		$1,522
Spinning fibers	$494 @	$787
Shingle fibers	$142 @	$325
Asbestos, Vermont, f.o.b. Hyde Park:		
Spinning fibers	$353 @	$383
Shingle stock	$172 @	$190
Paper stock	$114 @	$145
Waste, stucco or plaster		$82
Refuse or Shorts	$39 @	$72
Barytes f.o.b. cars:		
Georgia, crude, per ton		$18
Missouri, 94% $BaSO_4$, per short ton	$16 @	$18
Crude oil well grade, min. 4.3% sp. gravity, st (a)		$18
Imported, c.i.f. Gulf Ports, st.	$16 @	$18
Bauxite, long ton, f.o.b. point of shipment:		
Domestic, crude, 50 to 52% (not dried)	(c)$ 5.00 @	$5.50
Domestic, chemical, 55 to 58%	(c)$ 8.00 @	$8.50
Domestic, abrasive, 80 to 84%	(c)$18.00 @	$18.50
Imported metallurgical, per lt, f.o.b. Br. Guiana, dep. on grade		$7.14
Feldspar, bulk ton:		
Potash or soda feldspar, 200 mesh, ceramic grade	$18.50 @	$22.50
Glass feldspar, white, 20 mesh	$10 @	$12.50
Fluorspar, f.o.b. mines, bulk, 72½% effective, ton	$37 @	$41
60% effective CaF_2	$33 @	$36.50
Acid 97% concentrate, bulk, ton (eff. 12-1-56)		$50.00
Some sellers quote		$55
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00 @	$14.00
Magnesite, per ton dead-burned, bulk, f.o.b. Washington		$46
Mica—Domestic, f.o.b. mines, Punch 7¢ to 12¢ per lb. according to size and quality. Sheet clear, 1½ x 2-inch, 70¢ to $1.10; 2 x 2-inch, $1.10 to $1.60; 2 x 3-inch, $1.60 @ $2.10; 3 x 3-inch, $1.80 @ $2.30; 3 x 4-inch, $2.00 @ $2.60; 3 x 5-inch, $2.60 @ $3.00; 4 x 6-inch, $2.75 @ $4.00; 6 x 8-inch, $4.00 @ $8.00. Wet ground, very fine, $140 @ $155 per ton. Bulk sales, dry ground; $32.50 @ $70.00 per ton. Scrap, $25 and up.		
Ocher, Georgia, ton, in sacks	$26.50 @	$32.00
Pyrites, Spanish, per long ton unit of S. c.i.f. atlantic ports		Not quoted
Sulphur, per lt, f.o.b. U. S. mines: bright		$23.50
dark	$22.50 @	$23
Mexican, for use in Mexico, per metric ton, f.o.b. mines, 280 to 395 pesos, depending on use	$22.40 @	$31.60
For export f.o.b. vessel, lt, dep. on grade	$22 @	$24
Talc, f.o.b. works, ton:		
New York, purified	$18.00 @	$20.00
Vermont, extra fine		$12.50
Tripoli, Missouri, ton:		
40-mesh, cream colored		$50.00

(a) Some restricted sales at $11.50. (b) Corrected. (c) Nominal.

IRON AND STEEL

Pig Iron, gross ton, basic, Valley Furnaces		$66.00
Steel, f.o.b. Pittsburgh, billets, net ton		$77.50
Structural shapes, Pa., Ala., etc, 100 lb.	$5.10 @	$5.275

THIS MONTH IN MINING


130ft
55ft
Crushed compacted zone (about 500,000 tons)
Fused radioactive shell about 4in. thick (material originally in 10-15ft radius about center or about 700 tons)
Cavity (gas bubble)
Initial Effect
Cavity 25ft high (top at 386ft from center)
Broken caved rock permeable to water (at least 200,000 tons)
Adit
Damaged
Collapsed
300ft
200ft
130ft
55ft
Crushed rock impermeable to water
Radioative zone, major high confined to about 10ft thickness
Some Pre-Shot Properties of Rock*
Bulk density in situ: 1.9—2.0 gm/cm³
% Water by weight: 15—20%
% Connected voids: 25—35%
Compress. strength: 5,000—10,000 psi
Specific heat: 0.3 cal/gm
Sound velocity: 7,900 fps
Chemical composition: SiO₂—70%; Al₂O₃—12%; Fe₂O₃—1.5%; Na₂O—1.8%; K₂O—4.5%; MgO—0.5%; CaO—1.0%
*within 100 ft of center
Final Effect

UNDERGROUND ATOMIC BLAST equivalent to 1,700 tons of TNT was in tuff. Post-shot drilling indicates: about 500,000 tons were crushed to sand and at least 200,000 tons were broken by caving; temperature in crushed zone four months after blast averaged about 40 deg F higher than normal; and all fission products were in small zone of insoluble rock.

Rainier Blast Opens New Horizons

GERALD W. JOHNSON

THE FIRST completely contained nuclear detonation — code-named Rainier and fired in a long tunnel under a mountain at the Nevada Nuclear Test Site on September 19, 1957—gave results which suggest many applications to mining. As more is learned from this detonation, and as more industrial groups become aware of the tremendous potentialities inherent in the technique, many other applications will become apparent. In considering such possible tasks the imagination is free to explore projects hundreds or thousands of times larger than have ever before been undertaken, and jobs which would not be feasible, economically or technically, if attacked by purely conventional methods.

Purpose of this report is, first, to give the results of the detonation and, second, to suggest various possible industrial applications.

Before describing the detonation in detail it seems appropriate to give some general conclusions from the test explosion:

Radioactivity was completely contained. It was not possible to locate any detectable leak outside the cavity produced by the explosion using the most sensitive known techniques. And, while the studies are not yet complete, it seems that the radioactivity is tightly bound in fused tuff and the possibility of ground water contamination appears remote. To this date there has been no indication of any contamination of ground water nor is it expected.

Seismic effects were minor. Few people felt any motion at all at 2.5 miles. However, it has been reported that some seismic signals attributable to the shot were recorded as far as Alaska, some 2,320 miles from the test site. Seismic effects were so small that it was concluded explosions at least 100 times more powerful can be fired at the Nevada Test Site without causing any noticeable effects to the nearest off-site populated areas 30 miles away.

Originally A Military Project

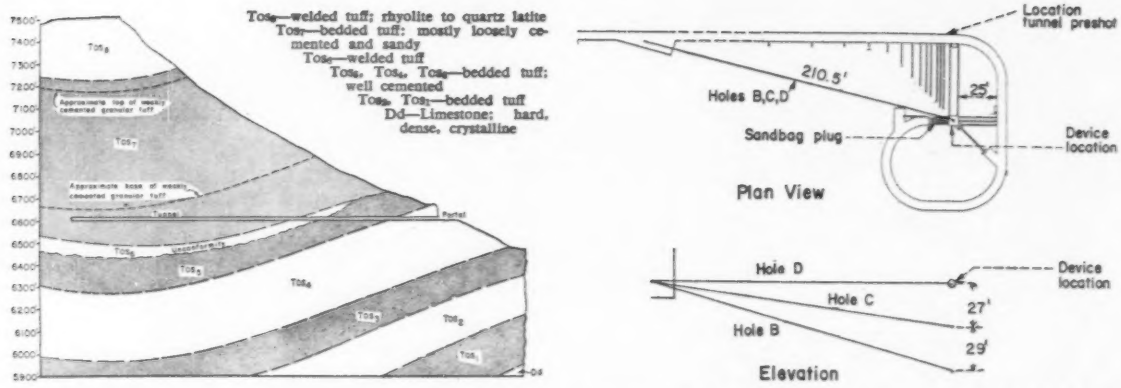
Initially, the objective of the underground test was to develop a new technique for testing nuclear devices. This technique was intended to eliminate such off-site problems as (1) radioactive fallout, (2) blast or noise, and (3). interference with airline traffic. For such underground shots the testing obviously would not be subject to expensive delays due to unfavorable winds or other meteorological factors. At the outset it was clear that many experimental measurements, particularly those requiring massive shielding, could be more readily accomplished underground than on the surface or on towers. An important exception was the measurement of total energy release either by radiochemical or other methods, and from a technical standpoint this measurement requires further study and evaluation.

The principal operational questions were the tunnel design factors which would lead to effective containment of the radioactivity; the appropriate necessary depth of burial; the local and off-site seismic effects; and the probability of ground water contamination.

A selected device of a relatively low yield (equivalent to 1700 tons of TNT) was fired in a 6x6x7-ft room at the end of a drift driven in the side of a mesa at the Nevada Test Site. Vertical depth of burial was 900 ft and shortest distance to the sloped surface was 800 ft. The geological structure consisted of a cap 200 feet thick of welded tuff, underlain by several layers of bedded tuffs.

Dr. Johnson is test division leader at University of California Radiation Laboratory, Livermore, California. (see p. 200).

THIS MONTH IN MINING *(Continued)*



MESA lifted 1 ft at surface-zero, fading out 500-600 ft away. Block parted 100-300 ft below surface. Horizontal effect was greater. Adit was spiraled so shot sealed itself. Results were probed by vertical and three flat holes and now a drift.

The first few hundred feet below the cap was lightly cemented; however, at the depth of the tunnel the structure was sufficiently strong that no timbering was required in tunnel except at portal.

The 1900-ft adit terminated in a spiral designed to be self-sealing. The basic concept was that the tunnel would collapse opposite the point of detonation before the shock could transport any radioactive material around and out the tunnel. In addition the room entrance was plugged with sandbags and two steel barrier doors were placed at 575 ft and 1,225 ft from the shot point. The principal apprehension prior to firing the shot was the possibility of fissures developing which would permit escape of radioactive products into the tunnel or to the surface of the mesa.

A post-shot drilling program, under the general guidance of Dr. Lysle Shaffer, professor of mining at the University of California, was carried out by E. J. Longyear Co. The purpose was to explore the shot area and to obtain radiochemical samples of the material produced by the explosion. The drill rig was modified to permit remote operation in the event that high pressure regions were penetrated in the course of the exploration. One hole was drilled vertically from the surface directed at the point of detonation, and three holes were drilled from inside the tunnel, also through the region of detonation.

A drift is being driven at the present time back toward ground-zero to gather more detailed information on the present structure of the medium, and to gain experience in mining through such media.

Results Indicate Mechanics

On firing the shot the tunnel collapsed out to a radial distance of 200 ft from the point of detonation—beyond that point for an additional 300 ft the tunnel was damaged but was passable. The remainder of the tunnel was essentially undamaged by the blast. All of the radioactive material was completely contained for none could be detected on the surface or in the tunnel.

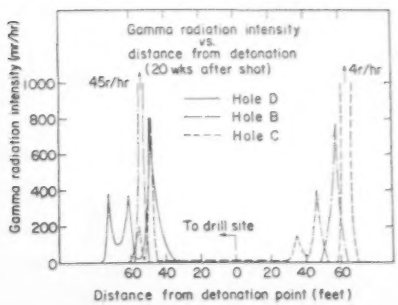
Drilling from the top of the mesa revealed a cavity at a depth of 500 ft. From that point down to the center of detonation drill water circulation was lost and there was very little core return. Drilling from inside the tunnel revealed two general zones. The first was met at a radial distance from the point of detonation of 130 ft. In this zone there was very poor core return but the circulation of drilling water was maintained. This condition prevailed until the inner radioactive zone was reached at a radius of 55 ft. From this evidence it was concluded that the rock was crushed but relatively impermeable in the zone defined between the radial distance of 55 ft and 130 ft. Inside the 55 ft radius circulation was again lost leading to the conclusion that here the medium was crushed and very permeable to water.

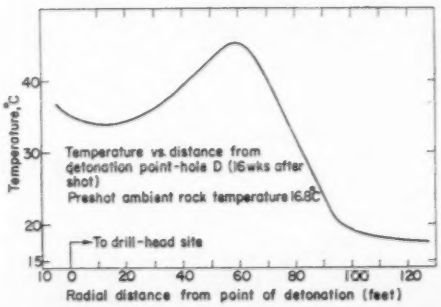
Analysis of air samples collected from this inner region using radiochemical methods revealed that this region was freely connected with the cavity discovered 400 feet higher. Radioactive samples were recovered from the ground-zero area and analyzed for radioactivity, and each of the holes logged for temperature and gamma radiation.

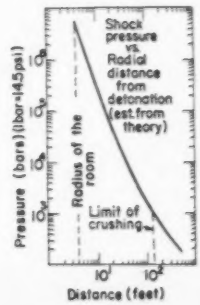
The temperature log made 16 weeks after the detonation reveals that the temperature begins to rise above ambient (16.8 deg C) at a radial distance of about 110 ft, reaching a maximum value of 45 deg C at 55 to 60 ft, and then leveling off at about 35 deg C toward the center. Subsequent logging in the lower holes confirmed the same general behavior except that regions having temperatures up to 90 deg C were discovered. Generally, in the crushed permeable central region heat appeared to have moved more freely than in the external regions where the medium was crushed but relatively impermeable.

Radiation logs were completed about 20 weeks after the detonation. The principal use is to show the present location of the active material and to aid in reconstructing the sequence of events during the explosion.

From the radiochemical results, ex-




Temperature vs. distance from detonation point-hole D (16 wks after shot)
Preshot ambient rock temperature 16.8C
To drill-head site
Temperature, °C
Radial distance from point of detonation (feet)


Shock pressure vs. Radial distance from detonation (est. from theory)
Radius of the room
Limit of crushing
Pressure (bars) (1 bar=14.5 psi)
Distance (feet)

Mining Calendar

Canada-United States Conference On Chemical Engineering. Montreal, April 20-23

Symposium on Mining Production Control. Annual Conference for Engineers, College of Engineering, Ohio State University, Columbus, May 2

North Texas Section, AIME, 3rd Biennial Secondary Recovery Symposium. Wichita Falls, Kan., May 5-6

Symposium on the Problems of Design and Emplacement of Mine Stope Fill. Montana School of Mines, Butte. May 9 and 10

3rd Annual Uranium Symposium, Uranium Section, AIME, Moab, Utah, May 9-11

34th Annual conference, Lake Superior Mines Safety Council, Allen D. Look, 329 Federal Bldg., Duluth, Minn. May 22 and 23

3rd Reactive Metals Conference, Niagara Frontier Section, AIME, Statler Hotel, Buffalo, N.Y., May 27-29

13th Purdue Industrial Waste Conference & Exhibit. Convention Hall, Philadelphia, Pa., Sept. 15-19

Rocky Mountain Minerals Conference, AIME, Salt Lake City, Sept. 17-19

cept for rare gases, it appears that practically all of the fission products were trapped in fused glassy tuff. From these measurements it was calculated that about 700 tons of the tuff near ground zero were melted initially by the explosion.

From the results of the core drilling, the temperature and gamma radiation logging, and the radiochemical analyses, it was possible to describe the mechanics of the explosion. At the moment of the explosion a cavity was produced with an inside radius of 55 ft. This was surrounded by a shell of fused material at 1200-1500 deg C about four inches thick. The shell stood long enough for fused tuff to drip from the roof because droplets 5-10 mm in diameter which had frozen in free fall and also short "icicles" two centimeters long were recovered. The cavity soon collapsed and progressive caving proceeded to a height of 400 ft above the point of detonation.

Temperature fell rapidly to that of boiling water (94 deg C at tunnel elevation) because of the dilution of cold rock falling from the roof and because of the presence of large amounts of water which then converted to steam and moved freely through the permeable region.

Civil Applications Look Good

Observations that the explosion produced at least 200,000 tons of crushed readily permeable rock and 500,000 tons of crushed rock, all of which was free of radioactivity except in a specifically localized zone, raises the possibility of the following applications:

1. Production of artificial aquifers for replenishing water tables by exploding a device in dry river channels such that progressive caving would proceed to the surface. The underground reservoir thus produced would store water from spring and storm runoffs and subsequently feed the water to permeable subsurface strata.

2. Breaking up of low grade ore deposits prior to leaching.

3. Exploitation of oil shales and tar sand oil deposits by loosening and heating to release oil directly.

4. Production of fill and riprap for road construction and other applications.

Many other practical useful applications will surely become apparent. And under auspices of the AEC, the University of California Radiation Laboratory is continuing its investigations in this field. The scope of the future program in this area is currently under study.

ACKNOWLEDGMENT—The ideas and results contained in this paper were contributed by many individuals from several organizations. Those who have contributed most directly are H. Brown, C. Adelmann, D. Rabb, G. Higgins, D. Nielsen, G. Kennedy, D. Griggs, E. Teller, M. Merritt, L. Vortman, F. Porzel, L. Moon, and C. Read.

A detailed unclassified report of the explosion is available from the Office of Technical Services, Department of Commerce, Washington 25, D. C. Price is $1. Title is: UCRL 5124—"The Underground Nuclear Detonation of September 19, 1957—Rainier—Operation Plumbbob" by Gerald W. Johnson, Gene T. Pelsor, Roger G. Preston and Charles E. Violet, dated Feb. 4, 1958.

As We Went to Press . . .

Termination of the zinc stockpiling program was announced March 31 by director Gordon Grey, who said the long-range zinc goal would be achieved with deliveries to the end of March.

A warning to the Administration was released by Sen. James Murray (D.-Mont.) that the Tariff Commission's delay on the lead-zinc producers' petition for increases was going to endanger the Reciprocal Trade Act Extension Bill. Lead-zinc producers have been rallying votes against the extension of the Act, and are intensifying their efforts with each Government delay.

Domestic metal and minerals producers' political push for more Government help to prop up sagging markets shifted into high gear in Washington at month's end. Their pressure, primarily on the Senate, came through clearly on these fronts:

Sen. Murray, as chairman of the Interior Committee, opened his third Minerals Subcommittee hearing on Administration policy in as many years with the flat contention that "something has to be done, and done quickly." (See p 132.)

Governors of Western States pressured the Administration for moves to cut unemployment and halt mine closings.

Senate Finance Committee again directed the Tariff Commission to renew its recently dismissed investigation into comparative production costs of tungsten in the U.S. and overseas, with an eye to new import controls.

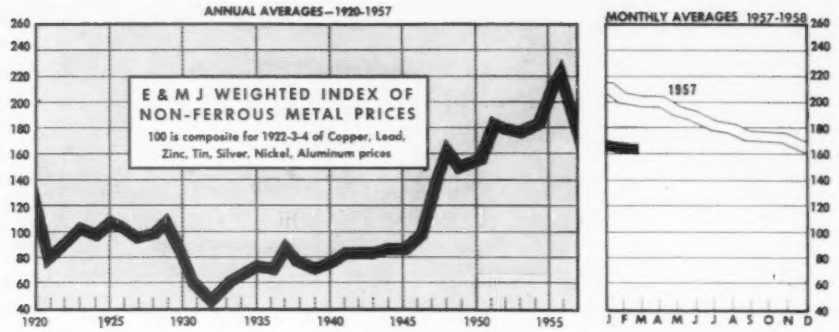
American Mining Congress asked House Ways & Means to authorize higher import tariff-quotas "wherever necessary."

Government appears adamant in continuing the trend away from Federal support of mining. Observers doubt success of any of the proposals except those pertaining to higher tariffs and possible import quotas.—And even these face stiff opposition.

Uranium ore outcroppings have been discovered on the Prince Harald Coast of Antarctica, according to the Japanese expedition. Seiji Kaya, chairman and a member of the Japanese Academy of Science says the ore samples will be analyzed in Japan.

E&MJ OUTLOOK

PRICES


ANNUAL AVERAGES—1920-1957
E & M J WEIGHTED INDEX OF NON-FERROUS METAL PRICES
100 is composite for 1922-3-4 of Copper, Lead, Zinc, Tin, Silver, Nickel, Aluminum prices
MONTHLY AVERAGES 1957-1958
1957
J F M A M J J A S O N D

MARKETS

E&MJ's metal price index continued its decline through March, falling off slightly from 168.38 for February to 167.31 for March.

●

AT HOME

A new direct-reduction process for the production of pig iron or semi-steel from iron ore has been announced by Koppers Co. and Strategic Materials Corp., joint owners of the Strategic-Udy process. See p 94 for description of the method. Next month's "New U.S. Patents" page will carry additional items about new developments in direct-reduction technology.

If you're keeping your own score on the recession and its impact on the mining industry as suggested in the chart and caption on p 109 of *E&MJ*, February 1958, plot the following points on vertical line "M" for March: *E&MJ* Metals Price Index, 167.3; *E&MJ* Index of Metals Use, 161; and FRB Index of Industrial Production, 129. Note also that for March we were three units too optimistic in our projection of the FRB index for 1958.

Capital expenditures by American business for new plants and equipment estimated for the first half of 1958 will total about $8.4-billion as compared with $9.6-billion for the first half of 1957.

It's too early to predict whether the fuel cell, described as a battery which makes electricity directly from hydrogen and oxygen or other hydrocarbons, will compete with batteries. However, it might be advisable for lead producers to check on this development.

●

LABOR

Mine, Mill and Smelter Workers, embarrassed by the fact that its 1957 campaign for tariffs would be unpalatable to IUMMSW members in Canada, shifted its position in March. Orville Larson, Western vice president, told delegates in Denver that "the tariff is a blunt instrument with which to limit imports." He countered with sharp criticism that the metals industry and the Government had failed to develop new uses for copper, lead and zinc.

●

ABROAD

Resurgence of the economics of Western Europe was completely underestimated by most American mining and business men in the boom year of 1955, and, even today, may not be fully appreciated. The index of industrial production of the 17 nations which comprise the Organization for European Economic Cooperation increased from 100 in 1953 to 125 in 1956, whereas that of the U.S. increased from 100 to only 107 during the same period. Both Anaconda and Kennecott comment in their recent annual report that the demand for copper in Europe was higher in 1957 than in 1956. Anaconda reports that the outlook for copper sales in Europe for 1958 is so good that its sales staff is having to explain to some European customers why they will not be able to get as much copper in 1958 as they are asking for.

O-B SHELLS AND PLUGS

. . . They've shortened the cycle with

O-B Expansion Shells and Plugs!

Bolting crews spend less time installing and wrenching bolts — have more time for drilling holes — when they use O-B expansion Shells and Plugs!

That's because O-B Shells and Plugs "go up easy and stay put" in any kind of top material. Bolt assemblies "go up easy" because the O-B shell flexes to overcome variations in hole diameter. They "stay put" even before wrenching because the weight of the assembly alone is enough to start expansion of the shell, and because the shell makes a firm contact with the sides of the hole.

This speedy installation leaves more time for drilling — means faster bolting, less exposure to unsupported roof, and an added measure of safety for bolting crew and all production workers.

Next time, order O-B Shells and Plugs! 4812-M

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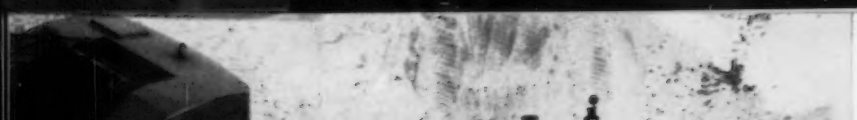
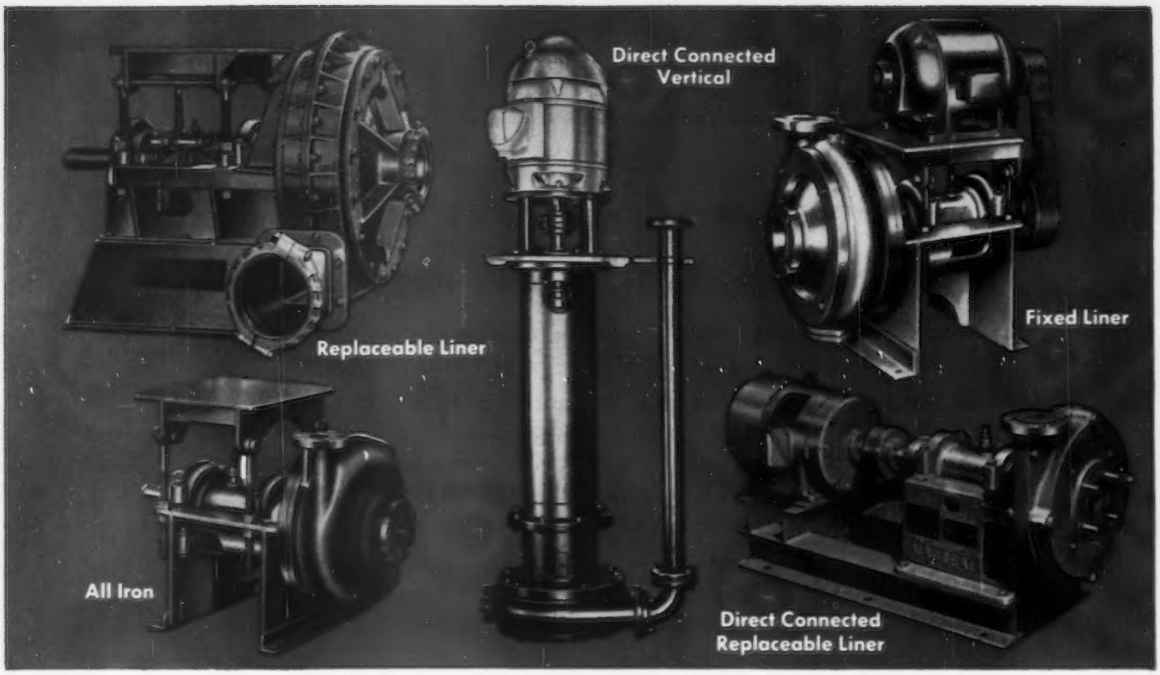


Shovel clean-up is only one of many jobs Tournatractor handles at Festus, Mo. for Aubuchon Silica Mining Division of Port-



VERSATILE VACSEAL

Every VACSEAL Pump is engineered for its specialized job

Galigher has long been associated with International Combustion Ltd. of London, England in the manufacture of the world famous VACSEAL Pump . . . a pump that has gained wide acclaim for its principle of positive suction without the use of sealing water. Without modifying the original VACSEAL Impeller design, Galigher has greatly widened VACSEAL'S scope of application . . . making it a truly diversified pump with the use of replaceable liners, removable bearing assemblies and with the introduction of vertical models.

FIXED LINER — The standard VACSEAL pump for abrasive or corrosive service with natural or synthetic rubber linings engineered to suit actual conditions. Casings and other parts can be factory relined and re-coated.

REPLACEABLE LINER — For applications where extreme wear is encountered or where high freight rates make replacement of castings prohibitive, steel-reinforced, non-collapsible liners can be furnished.

ALL IRON OR ALLOY — For such applications as dredging, coarse sand, gravel, lime slurry and corrosive solutions requiring alloys.

VERTICAL — Special mountings for dry-pit and wet-pit service.

SIZE	CAPACITY
1½" x 2"	10 — 120 gpm
2" x 2½"	50 — 190 gpm
3" x 4"	150 — 500 gpm
4" x 6"	300 — 700 gpm
6" x 8"	500 — 1500 gpm
8" x 10"	800 — 3600 gpm

Through the cooperation of our staff of experienced mill operators, metallurgists and engineers we are able to help you in the selection of a pump installation to suit your needs. We welcome your inquiries.

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GALIGHER PRODUCTS: AGITAIR® Flotation Machine, VACSEAL Pump, Geary-Jennings Sampler, Acid-proof Sump Pump, Geary Reagent Feeder, Laboratory AGITAIR® Flotation Machine, Laboratory Pressure Filter, Laboratory Ball Mill, Rubber Lined and Covered Products, Plastic Fabrication.

Shovel clean-up is only one of many jobs Tournatractor handles at Festus, Mo. for Aubuchon Silica Mining Division of Portage-Manley Sand Co. Working in extremely abrasive sand, and across uneven hard rock floors, has been no problem and maintenance costs have been very low.

How Aubuchon keeps ahead of tight production schedules

. . . cuts costs on tractor maintenance

Pit shovel, to wash plant, to rail car — in an hour. That's a normal scheduling at Aubuchon Silica Mining Division, Festus, Mo. Owned by Portage-Manley Sand & Gravel Co., Rockton, Ill., the firm ships many carloads a week of fine silica used in foundry cores and crystal glass.

Aubuchon does no stockpiling, depends on steady production to fill orders. Extended downtime on any machine, therefore, could halt shipments. One of the major availability problems is that of the pit tractor. Servicing the stripping and clean-up operations over the entire pit and plant area, this machine must continuously cross rough, rocky areas . . . working in silica so fine and hard it's been described as "sharp as grinding compound".

"Tournatractor® only machine that can do our tractor work . . ."

Since 1952, Aubuchon Silica Mining's tractor jobs have been handled by a rubber-tired LeTourneau-Westinghouse Tournatractor. As Plant Manager Ira Kent says: "The abrasion, rough going, and back-and-forth travel is too rough for crawlers. Tournatractor is the *only* machine we've seen that can do our tractor work."

Tournatractor's main assignments at this pit are stripping overburden to expose new sandstone, and cleaning up around shovels. But its rubber-tired mounting, sealed anti-friction drive, speed and "go-anywhere" ability let it take on a full circuit of haul-road building and maintenance, stripping, shovel and general clean-up dozing at the pit, mill, and yards.

Maintenance now no problem

How has Tournatractor stood up under conditions so tough? Let Manager Kent tell it: "The last crawler we had was junk inside of 11 months. We've worked Tournatractor 45 hours a week for almost 5 years, *with no real trouble*. On our rough hard rock floors and with free silica sand all over, that's something!

"Our one and only major repair expense in all that time has been replacement of the torque-converter oil-seal and bearings. We've never done anything to the engine . . . never broke an axle, chipped a gear, or had a single major thing go wrong!"

Ask for a demonstration

Tournatractor has minimized maintenance problems for Aubuchon Silica Mining, while doing a lot of work quickly, efficiently. Investigate now what it can do at *your* pit. Let us send you full facts and arrange for an on-the-job demonstration. No obligation!

Tournatractor has plenty of power to doze rocks too big for pit shovel. Big, rubber-tired machine also cleans up fast to let drilling crew set next charges earlier.

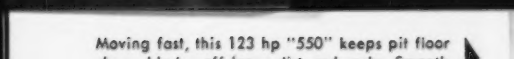
Stripping overburden, Tournatractor slot-dozes — using walls of slot as "natural sideboards". Method keeps dirt from spilling off edge of blade for bigger loads with same effort. "Fill-in" jobs like this keep Tournatractor busy the year 'round.

CT-1500-M-1

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

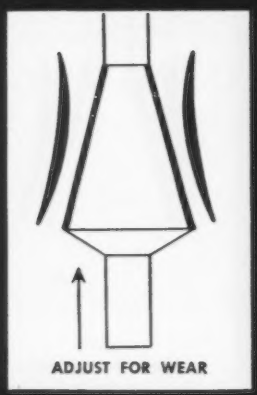
A Subsidiary of Westinghouse Air Brake Company

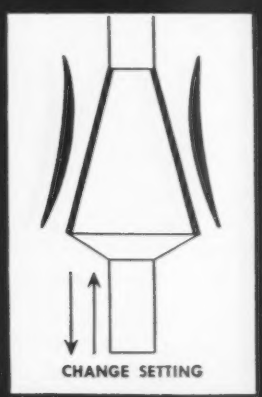
Where quality is a habit

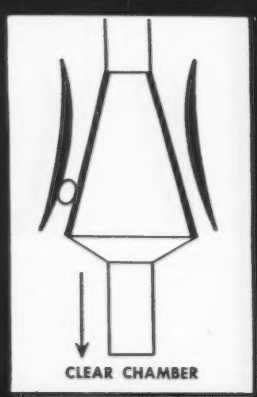


Moving fast, this 123 hp "550" keeps pit floor

Superior crusher with Hydroset mechanism



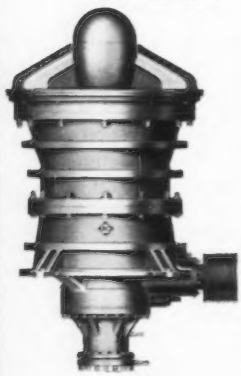




Maintain circuit balance under varying operating conditions

The flexibility of a *Superior* primary or secondary crusher assures you maximum efficiency for the entire circuit under changing operating conditions. You can vary capacity by changing eccentric throw. You can change crusher settings in less than a minute. You maintain uniform product size easily over long runs — by simply flipping a switch to compensate for wear on mantle and concave. Result? Smooth flow of desired tonnage with minimum circuit adjustments — lower operating costs.

Flip the switch



The exclusive *Hydroset* mechanism in the *Superior* crusher raises or lowers mainshaft hydraulically, in less than a minute. This mechanism not only gives you "one-man, one-minute" product control but also helps clear the crushing chamber in case of power failure or other emergency conditions.

Bulletin 07B7870 will give you all the details. Ask your A-C man for a copy, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

A-C ALLIS-CHALMERS

A-5606

ALLIS-CHALMERS

Superior and Hydroset are Allis-Chalmers trademarks.

Moving fast, this 123 hp "550" keeps pit floor clean, blades off loose dirt and rocks. Smooth access saves wear on haulers' tires. Regular clean-up, improved drainage, prevents dirt and refuse from weathering into levels of pit floor.

9 WAYS

to increase pit output and cut cost per ton

You may think of your grader simply as a maintenance tool. But in the hands of a good operator, a versatile, modern high-speed grader actually steps up mine and quarry production, and cuts operating costs. Check these 9 big ways increased grader capacity can boost profits.

1 Regular, more frequent maintenance of haul roads—smooth roads speed hauling, save tire wear, cut hauler down-time, improve safety.

2 Quick clean-up after blast—grader provides a fast, inexpensive way to move scattered fragments back against toe—thus protecting men, machinery, tires and other equipment working around pit, speeding up all pit operations.

3 Clean pit floors—regular routine of maintaining wide, clean traffic-ways that make all areas of pit or quarry quickly accessible, pays off. Equipment can always travel to any assignment by shortest route. Regular clean-up, improved drainage, prevents dirt and refuse from weathering into ore or coal below floor.

4 Maintain good housekeeping around plant—you need ample grader capacity to keep roads, runways, working areas around plant neat, clean, and workable at all times. Grader quickly and efficiently levels or removes the occasional spill left by heaped trucks...from around grizzlies, conveyors, trestles. A clean plant area speeds mobile equipment operation, reduces dust.

5 Keep stockpile toes pushed in—weather and loading operations result in spread of toes around stockpile. This limits working space, wastes stored material. Also, working thinly-spread toes down-grades material, increases loading cost.

6 Keep dumps smoothly spread and level—regular grader service can spread dumped material clear over edge. Offset blade reaches far out beyond wheels. A smooth, level, dry, dump speeds both hauling and dumping, cuts equipment costs. Grader can easily smooth haul road as it travels to and from the dump.

7 Clean ore benches of washed-down dirt—every rain washes dirt into upper benches, lowers quality of mined material. Prompt grader service halts "wash", provides planned drainage, piles washed-in material for easy removal by scraper or truck.

8 Assist exploration teams—a modern grader can build a well-graded and drained roadway in a matter of hours...speeds exploration work by maintaining good roads for hauling men and equipment.

9 Keep drainage open—with just a few hours work per week, a modern grader will keep ditches clean ...provide fast run-off, preventing seepage of dirty water into pit bed. Planned maintenance eliminates erosion of haul roads, keeps trucks and shovels operating on dry footing.

Check capacity of your present graders

It will pay you to re-assess the role and capacity of your present graders. If your machines are more than a few years old, you will probably realize a substantial increase in grader productivity by replacement with modern, fast, powerful, big-capacity graders. Call or write for full information on L-W Adams heavy-duty graders. Seven models: 190, 160, 135, 123, 115, 80, and 60 hp. Choice of GM or Cummins engines on 6 larger models.

This 160 hp Adams 660 grades haul roads, at speeds to 6.7 mph, in 4th gear. Unit smooths surface for high-speed movement of production haulers. Travel speeds to 26 mph.

Adams—Trademark AG-1352-M-b

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Where quality is a habit

Air Legs Outdrill Drifters, Cut First Cost 53%

Le Roi H10AL Air Legs slash drill setup time 75%.

Boost ore production at America's largest underground mine

"Our 70 Le Roi H10AL air legs saved us $70,000 in initial outlays for drilling equipment. But more important than the big first-cost saving," reports R. M. Stuart, assistant planning engineer for the Climax Molybdenum Co., Climax, Colo., "is the fact that we are drilling more footage than ever before and at less cost."

That's quite a feat when you consider that Climax mines 34,000 tons of molybdenum ore daily. "With our schedule," Stuart explains, "there's no time for preventive maintenance. The air legs are worked until they break down."

"Our records show that for the past 10 months, the Le Roi air legs have drilled a total of 570,500 ft. at a repair cost of $.057 per ft., including labor and parts." Stuart explains that this is 10% lower than the repair cost of drifters for the same footage.

Operators Prefer Air Legs

Stuart reports that the Le Roi air legs are first choice of operators at Climax. He points out that the complete unit weighs 70 lbs. and can be set up in less than one minute. Drifters, he adds, weigh 250 lbs. and require at least 20 minutes — usually longer — to set up for drilling.

The compact H10AL is ideal for operation in close quarters. Its pivot-mounted drill enables the operator to sink straight holes from any angle. This cuts down the number of moves and assures maximum blasting efficiency.

Most important, the Le Roi H10AL takes the hard work out of drilling. The air leg absorbs recoil, and advances the drill into the rock. The results: More footage and less operator fatigue — a blessing on this job, since drilling is done at an altitude of 11,500 ft. where any physical effort hastens fatigue.

Why not ask your local Le Roi distributor to demonstrate the H10AL on your job site? Once you try it, you'll buy it!

Le Roi H10AL air legs can be used as stoppers, drifters, or sinkers. The switch can be made by simply changing the position of the base and the direction of the drill.

Operator merely plants the base of the H10AL air legs on the ground, sets the steel, and starts drilling. Stuart reports that the air leg uses 25% less air than a drifter, thus extending compressor life.

Change angles . . . fast!

LE ROI Division of Westinghouse Air Brake Co., Milwaukee 1, Wisconsin, manufacturers of Newmatic air tools, Tractair®, portable and stationary air compressors, and heavy-duty industrial engines. Write us for further information on any of these products.

WABCO

AT-801

Replaces power shovel with 4-In-1

. . . gets versatility unlimited!

Digging, 'dozing, clearing, loading —this International Drott TD-9 4-In-1 replaces the limited-duty performance of a ⅜ cu. yd. power shovel. Tony Pacifico Company, Charleston, W. Va., practically builds a 100-ton-per-hour stone-quarrying operation around 4-In-1 versatility. Above, using bulldozer action, the 4-In-1 is removing overburden from a 60-foot-thick rock stratum. Owner formerly had to hire a dozer in addition to the power shovel to clear and strip!

Using a back-drag motion of the clam lip, with high-reaching 4-In-1 clamshell action, the Pacificos do a fast, low-cost job of bank-sloping—to forestall earth slides into the quarry. The exclusive, big-capacity clamshell also gives speedy "stand-and-fill" action of loose materials.

Pushing over a hardwood sapling, the Pacifico 4-In-1 is used for land-clearing ahead of stripping quarry overburden. For uprooting larger trees, a grubber blade can replace the 4-In-1 bucket—to apply the tremendous lifting power of exclusive Drott pry-over-shoe break-out action!

Sticky clay dumps clean—quits gumming the works and slowing overburden removal when the Pacificos use 4-In-1 clamshell bottom dumping. Opening the clam pulls sticky materials from bucket surfaces—gravity pull does the rest, to give the 4-In-1 positive self clean-out!

Prove 4-In-1 four-machine versatility unlimited! Move the machine-selector lever — try the built-in *clamshell, "carry-type" scraper, bulldozer and Skid-Shovel* actions. Compare exclusive pry-over-shoe break-out action for digging hard materials other rigs can't budge! See how exclusive Hydro-Spring swallows shock, protects performance. Ask your International Drott Distributor for a 4-In-1 demonstration.

International Harvester Company, Chicago 1, Illinois
Drott Manufacturing Corp., Milwaukee 15, Wisconsin

INTERNATIONAL® DROTT®

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Gentlemen:
Please send 4-In-1 catalog literature checked:

☐ 1-yd. TD-6 (CR-640-H) ☐ 1½-yd. TD-9 (CR-627-H) ☐ 2¼-yd. TD-14 (CR-635-H) ☐ 3-yd. TD-18 (CR-632-H)

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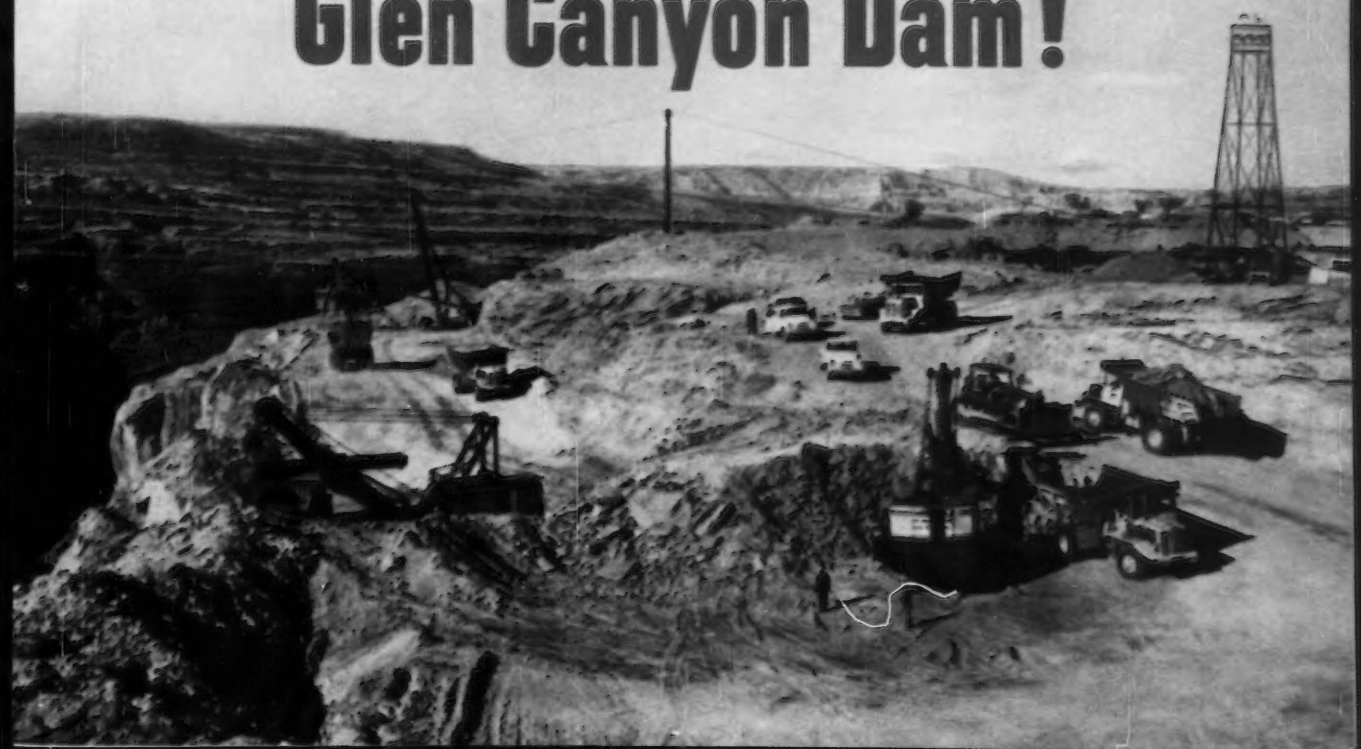
Explosives Department
30 Rockefeller Plaza, New York 20, New York

DISTRICT SALES OFFICES: St. Louis, Missouri; New York City, New York; Latrobe, Pennsylvania; Pottsville, Pennsylvania; Scranton, Pennsylvania; Dallas, Texas; Salt Lake City, Utah; Bluefield, West Virginia

THE CYANAMID LINE: High Explosives • Permissibles • Seismograph Explosives • Blasting Agents • Blasting Powder • Blasting Caps • Electric Blasting Caps • Blasting Accessories

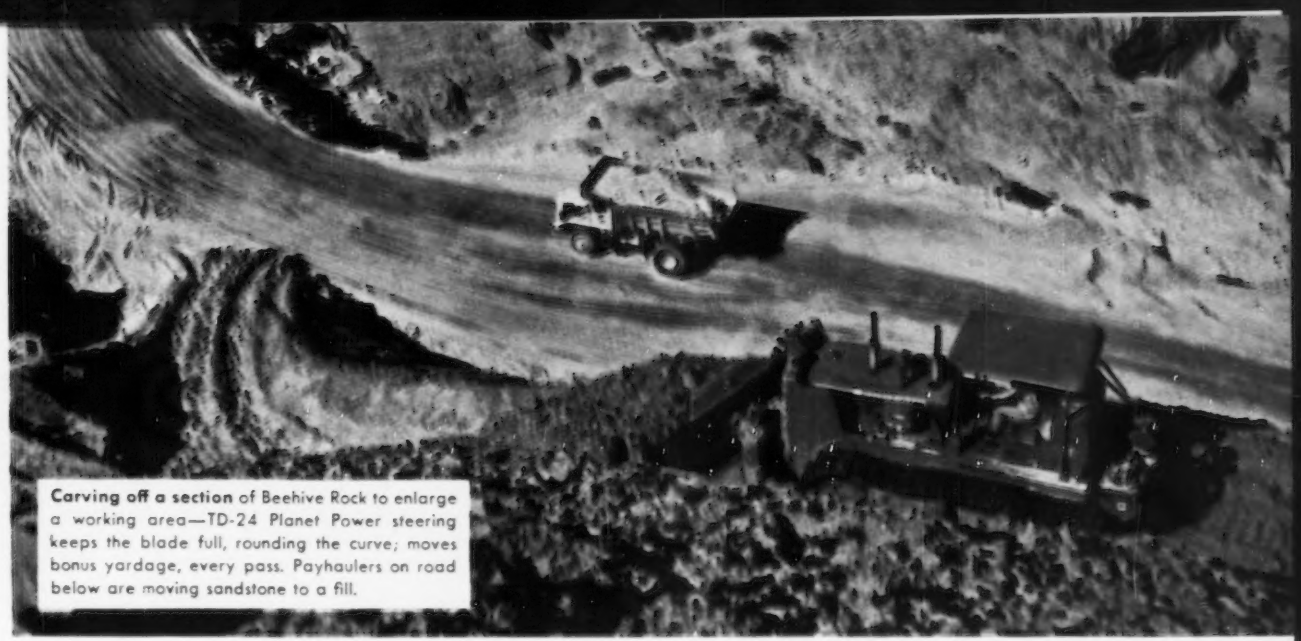
Merritt-Chapman & Scott mobilizes International® fleet to build colossal Glen Canyon Dam!



Noon time is inspection time as Merritt maintenance men, using International welder and shop trucks, roll up to Marion power shovel for fast, on-the-job service.

$108 million contract crawlers, haulers,

"95" Payhauler fleets keep busy on both sides of the 700-foot-deep canyon. These three units are hauling shovel-loaded rock from spillway excavation on the huge Glen Canyon Dam project.



Carving off a section of Beehive Rock to enlarge a working area—TD-24 Planet Power steering keeps the blade full, rounding the curve; moves bonus yardage, every pass. Payhaulers on road below are moving sandstone to a fill.

rolls on schedule with International® trucks and service!

8-passenger International Travelall, with hill-climbing four-wheel-drive, transports engineers and surveying equipment over rough terrain right to the dam site.

Here a rugged International truck with boom rig is used by electrical linemen to set up important transmission lines on the east side of the Colorado River.

On-the-spot maintenance. International shop truck moves in as shovel takes "fuel break" from International cab-forward tanker.

Big capacity. Six-wheel heavy-duty International truck with 5,000-gallon tank sprinkles water for compaction of road base.

Ready for any emergency. Merritt medical crews use International Travelall ambulances, complete with oxygen and first aid equipment, to provide mobile first aid. One stands by on each side of the river.

MERRITT-CHAPMAN & SCOTT CORPORATION is shooting to complete its $108,000,000 Glen Canyon Dam contract—biggest competitively bid job ever awarded to a single contractor—well ahead of the specified seven-year limit. A big fleet of International equipment helps keep this huge Bureau of Reclamation project on the Colorado River in Northern Arizona rolling at record pace.

Planet Power-steered TD-24 crawlers prove the worth of full-time live power on both tracks—blading bonus loads 'round the curves. Grade-beating "95's" high-balling rock show why a load-and-road-matched Payhauler® fleet—bonus-powered with turbo-charged diesel engines—belong on this tough, high-altitude job. International trucks are here, there, and everywhere—handling a multitude of different material, equipment, and personnel-carrying assignments.

And complete International parts and service is minutes close to insure high performance availability of every International machine.

Making ready for power. Conventional International truck with engine-driven auger sinks holes for transmission lines.

Truck-roller lubrication of the TD-24's only needs to be done each 500 working hours. A cab-forward International truck, provides an efficient, mobile "service station." This compact International was chosen for exceptional maneuverability.

Prompt, performance-backing International service ... company and distributor... *keeps 'em rolling!*

The complete service resources for which International is world-famous are on the job for Merritt-Chapman & Scott—to help keep all International equipment rolling and producing!

It makes no difference that the job is remotely-located and 125 miles from the nearest rail-head. International, the distributor, and the dealer concerned have augmented existing parts stocks and facilities—have set up supply channels that assure on-the-spot parts availability.

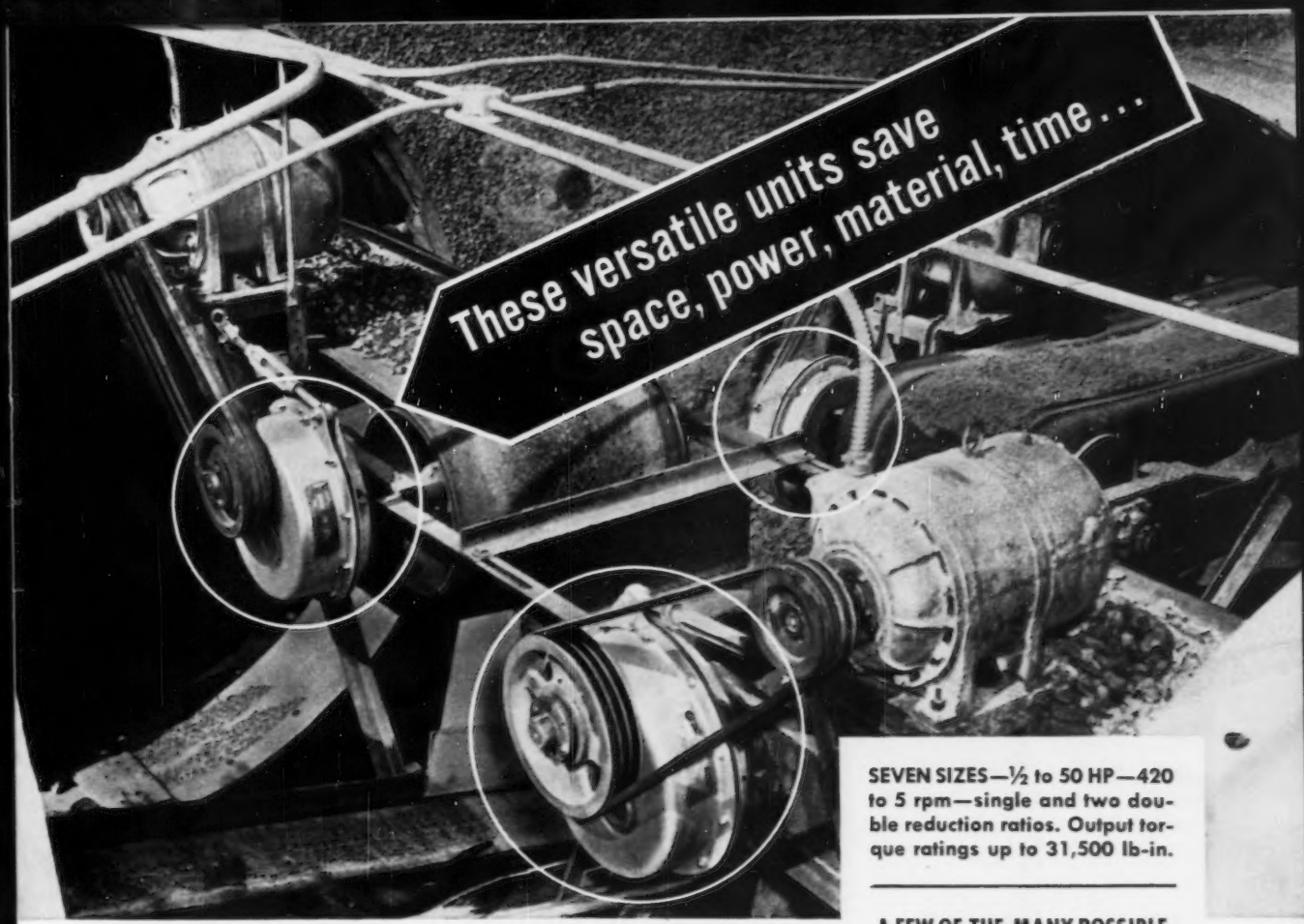
Specialized distributor and company servicemen are so promptly available it's as convenient as a "down-the-street" service department.

YOU CAN HAVE THIS SAME big-capacity, specialized International performance—wherever you operate and on whatever scale—and with top performance-backing company, distributor and dealer service. See your International dealer or distributor for a demonstration of the construction equipment and motor trucks you need for high-balling your next job!

International Harvester

International Harvester Co., 180 N. Michigan Avenue, Chicago 1, Ill.

A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors . . . Motor Trucks . . . Self-Propelled Scrapers . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Haulers . . . Diesel and Carbureted Engines.



SEVEN SIZES—½ to 50 HP—420 to 5 rpm—single and two double reduction ratios. Output torque ratings up to 31,500 lb-in.

FALK ALL-STEEL Shaft Mounted Drives

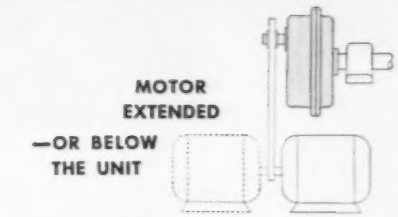
The photograph above typifies the way FALK Shaft Mounted Drives furnish the economical solution to problems of efficient speed reduction in a limited space. Within their rated capacities, these versatile reducers are designed to drive any machine and to fit any space requirement.

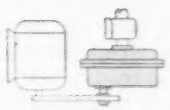
FALK Shaft Mounted Drives mount on the driven shafts and are connected by V-belt or chain to any convenient rotating power source. Unlimited choice of output speeds between 420 and 5 rpm is made possible by varying the ratio of driving sheaves or sprockets.

These units, with precision-cut gears of highest efficiency, use a minimum of power. They need no adjustable motor bases or slide rails; thus they save material. And, because they are readily available and easily installed or moved, they save time. Best of all, they are backed by FALK's unmatched experience in precision-gear manufacture.

Promptly available from factory and distributor stocks, from *coast to coast*. Ask your Falk Representative or Distributor for details—or write us for **Bulletin 7100.**

A FEW OF THE MANY POSSIBLE DRIVING ARRANGEMENTS





THE FALK CORPORATION, 3001 W. CANAL ST., MILWAUKEE 1, WIS.

Representatives and Distributors in Most Principal Cities

Manufacturers of

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

FALK

...a good name in industry

Where the going gets rough...

get tough

with Lukens "T-1" Steel!

TRADE-MARK

WRITE FOR THIS BOOKLET TODAY

■ Wherever rock and gravel, coal and ores come in violent contact with machine and equipment parts, Lukens "T-1" steel—*especially extra tough 321 min. BHN quality*—fights back at wear and abrasion with spectacular success.

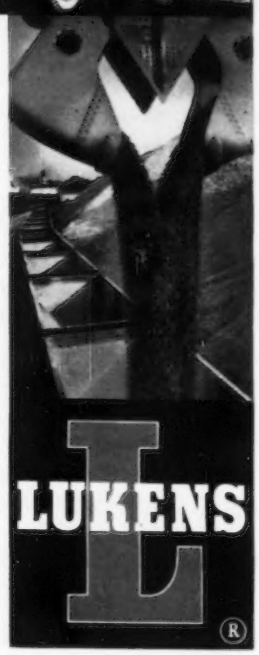
It is readily fabricated. You can form or weld it in the field or shop, from stock plate sizes immediately available. It can be used to replace or repair worn bucket teeth, truck and mine car bodies or liners, dozer blades, dipper sticks, crusher teeth, chutes, and many other parts.

Far stronger for its gage than conventional steel, it requires less metal to do equivalent jobs. It remains tough even at sub-zero temperatures.

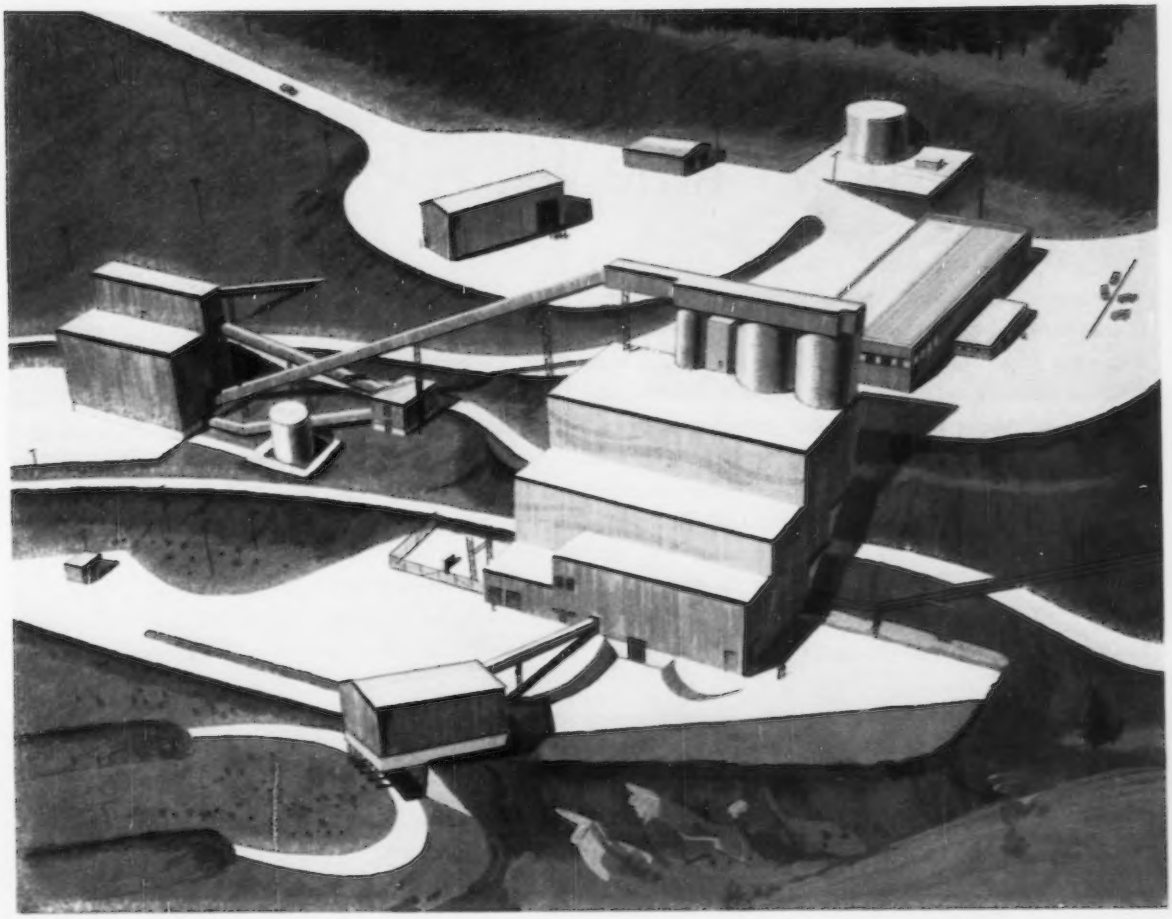
Contact your nearest warehouse listed below, or write Manager, Marketing Service, 142 Lukens Building, Lukens Steel Company, Coatesville, Pennsylvania. Ask for special bulletin, *"Lukens 'T-1' for Toughness."*

WAREHOUSES

Ashland, Kentucky, Mansbach Steel Co., 19th St. & River Front
Baltimore 2, Maryland, Wm. G. Wetherall, Inc., 317 President Street
Birmingham 2, Alabama, O'Neal Steel, Inc., P. O. Box 2623
Cleveland 6, Ohio, Mills-Wolf Steel Co., 10006 Carnegie Avenue
Los Angeles 33, California, The R. J. M. Company, 238 Mission Rd.
Montreal, Quebec, Can., Drummond, McCall & Co., Ltd., 930 Wellington St.

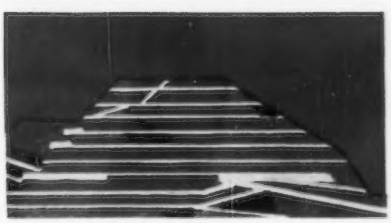


HELPING INDUSTRY CHOOSE STEELS THAT FIT THE JOB



Currently under construction—the Moose Mountain iron ore beneficiation plant near Sudbury, Ontario. For this client, a subsidiary of the National Steel Corporation, the engineering, procurement, and construction are being performed by Canadian Bechtel Limited.

Mobilized Experience



Extensively used by the oil, natural gas and chemical industries, Bechtel experience is also helping in the development of mineral resources. Every service necessary for the complete realization of a project is available from one organization.

...under single responsibility
...or with limitations to specific functions
...or as managers of engineering and construction

BECHTEL CORPORATION *Engineers and Builders for Industry*

SAN FRANCISCO • Los Angeles • New York • Houston
CANADIAN BECHTEL LIMITED • Toronto • Vancouver

"In mining, you need machines that stay on the job because down time will ruin you!"

To be more specific, I. D. Gibson of Glenwood Mining Co., Glenwood, Alabama, says: "This is one operation you have to keep going, because down time will ruin you. We have found Caterpillar products give us better on-the-job results and I don't think there is anything that will give you longer life."

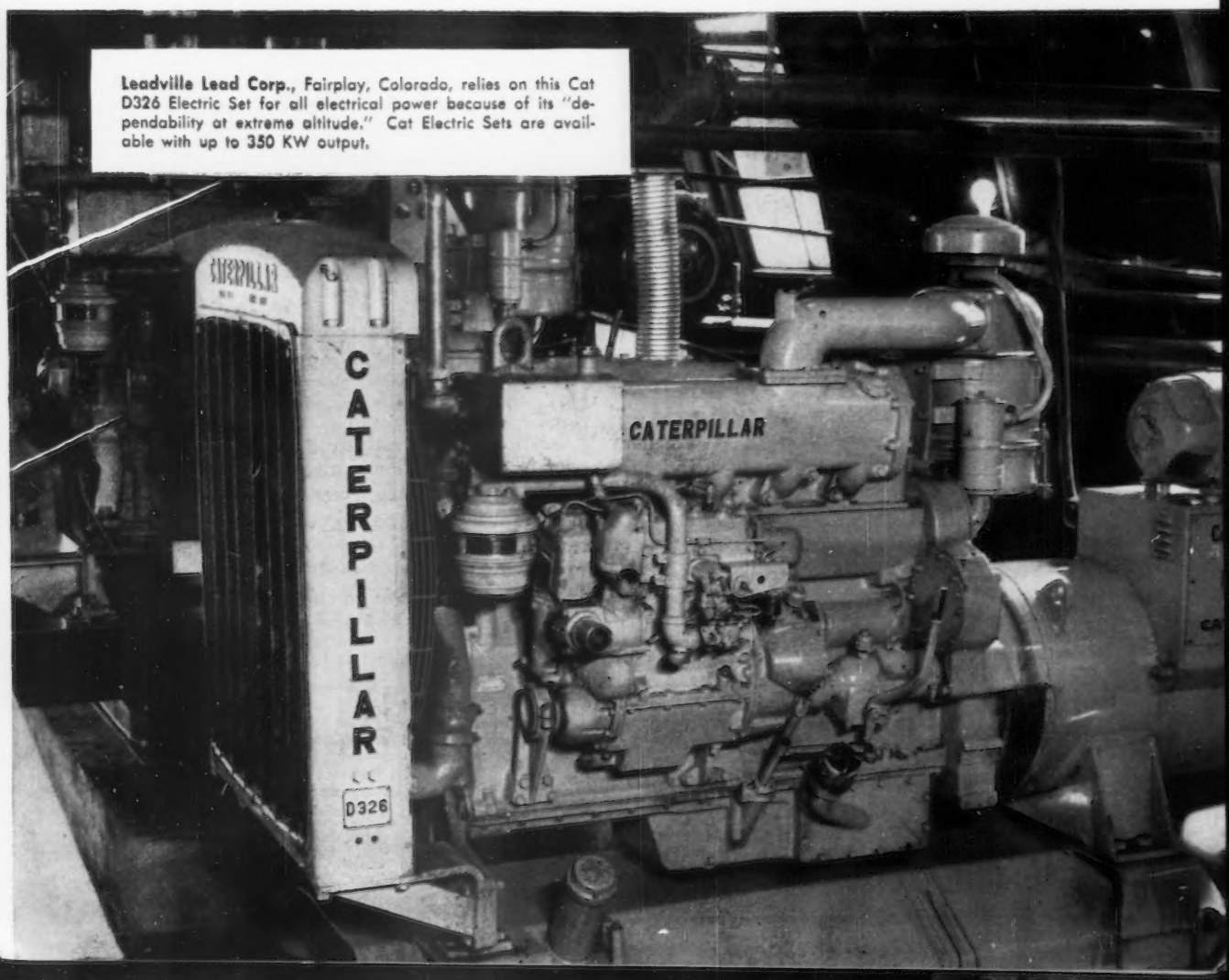
Mine owners operating at a profit have Cat power on electrical loads and powering shovels, pumps, compressors, drills, crushers, hoists, locomotives and shuttle cars. If *you* have a job that can't stop, you will be wise to rely on Cat power 100%. Electric Sets are available up to 350 KW and engines to 650 HP (maximum output capacity).

These engines are the same basic power plants used in the Cat-built Tractor line. So by specifying Cat Engine power, your parts stock can be cut.

Wherever you buy, Cat power can be supplied. The largest and most fully equipped dealer organization in the heavy construction field gives you telephone-quick service. And more than 150 manufacturers offer Cat power in their new equipment.

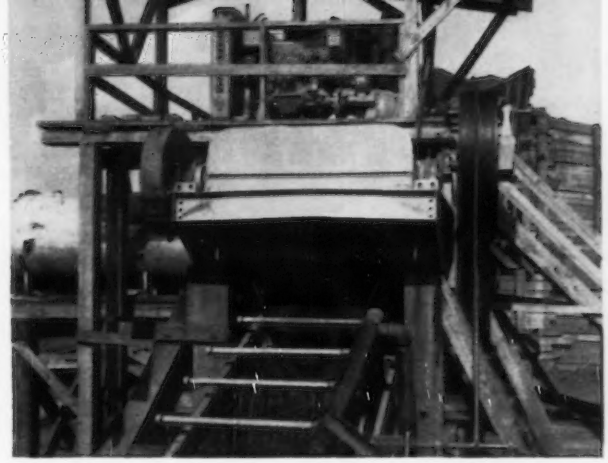
So see your nearby Caterpillar Dealer for your power needs. And be sure to specify Cat power when selecting new equipment.

Engine Division, Caterpillar Tractor Co., Peoria, Illinois, U.S.A. Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.



Leadville Lead Corp., Fairplay, Colorado, relies on this Cat D326 Electric Set for all electrical power because of its "dependability at extreme altitude." Cat Electric Sets are available with up to 350 KW output.

All New



I. D. Gibson of Glenwood Mining Co., Glenwood, Alabama, relies on a number of Cat Engines, including this D337 (Series F) because, "In mining, you need machines that stay on the job because down time will ruin you." It's the reason why mine operators from coast to coast prefer Cat Engines.

This Lorain L50 with a Cat D318 Engine here performs for Davis Bros.' iron ore stripping operation in Troy, Alabama. M. E. Davis, partner, says, "We're so well satisfied with the performance of our D318, I don't believe we will ever try to find if there is a better engine made."

Cat D8 Tractor removes overburden from iron ore at the Peeks Mine west of Glenwood, Alabama. The Glenwood Mining Company standardizes on Cat power in tractors, shovels, log washers and pumps. It's easier on operators and engine parts are interchangeable.

This Link-Belt LS98 Dragline is powered by a Cat D318. Here it is loading out overburden on a Glenwood Mining Co. job. For modern, heavy-duty diesel power, mining operations depend on Caterpillar — champion of the tough jobs.

ENGINE POWER BY CATERPILLAR

Cat diesel power is available in these excavators

American Hoist & Derrick Co.
Baldwin-Lima-Hamilton, Lima Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Byers Manufacturing Company
Dominion Engineering Works, Inc.
Fiorentini, Canada, Ltd.
Gar Wood Industries
Hanson Clutch Co.
Harnischfeger Corporation
Industrial Brownhoist Co.
Insley Manufacturing Co.
Koehring Company
Link-Belt Speeder Corp.
Little Giant Crane & Shovel Co.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Ohio Locomotive Crane Co.
Quick-Way Truck Shovel Co.
Sargent Engineering, Inc.
Sauerman Bros., Inc.
Thew Shovel Co.
Warner & Swasey (Gradall Division)
Washington Iron Works
Wellman Engineering Co.

Dept. EM4, Engine Division
CATERPILLAR TRACTOR CO., Peoria, Illinois, U. S. A.

Send me more information on Cat Engines.

- ☐ I am interested in general information.
- ☐ I would like the names of the 150 manufacturers who can supply Cat power in new equipment.
- ☐ I would like information about repowering.

Manufacturer _____ Model No. _____

Name _____

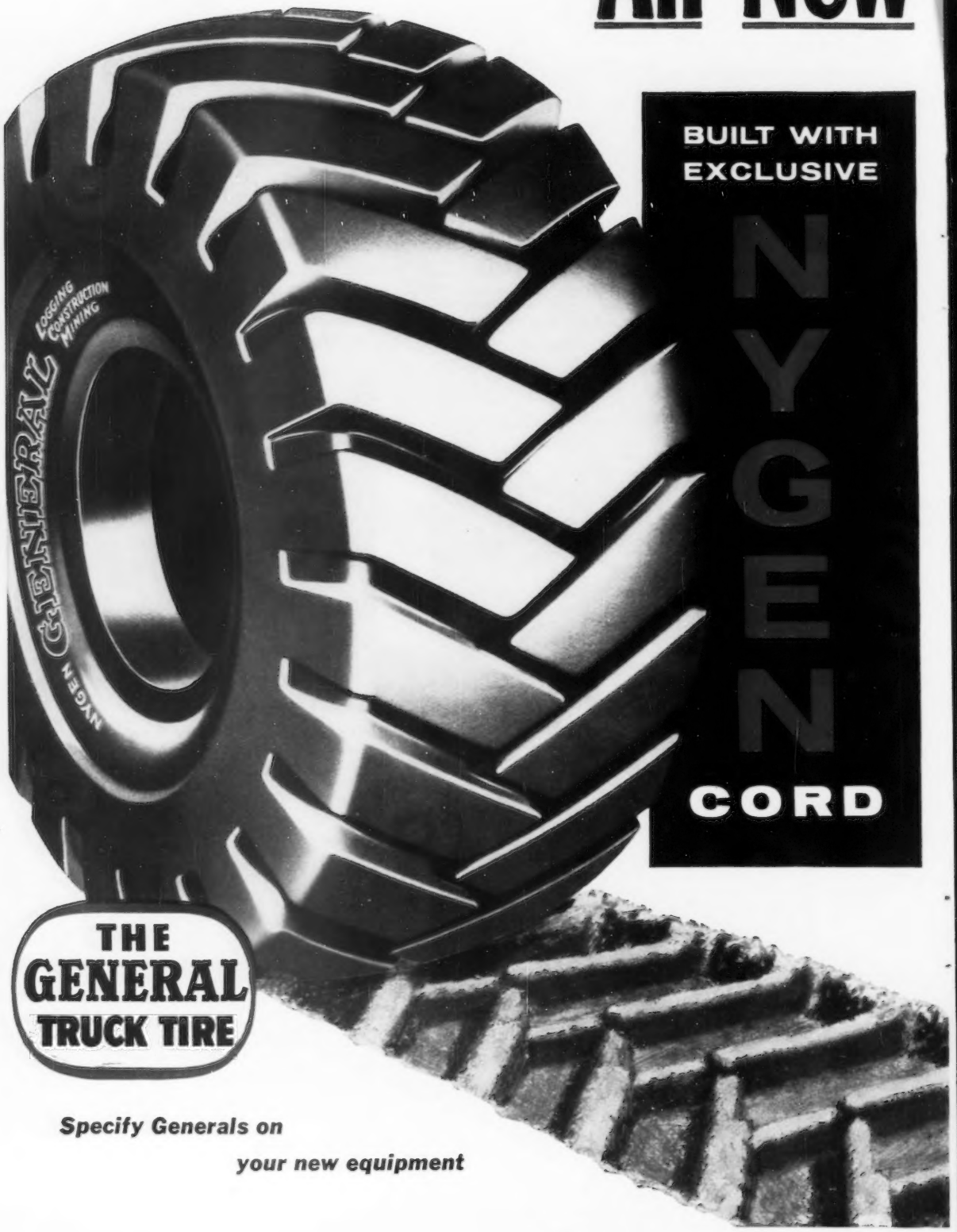
Company _____

Address _____

City _____ Zone ____ State _____

From Bead to Tread!

All New



BUILT WITH EXCLUSIVE

NYGEN

CORD

THE GENERAL TRUCK TIRE

Specify Generals on your new equipment

From Bead to Tread!

THE GREAT NEW, WIDE-BASE

GENERAL

L LOGGING **C** CONSTRUCTION **M** MINING

Offering unsurpassed traction, flotation and job-hazard protection!

Combining a far deeper, wider and huskier tread with exclusive Nygen Cord construction, the all-new General LCM promises, and produces, ever-lower tire operating costs. Engineered to provide traction and flotation beyond all comparison, the General LCM minimizes rolling resistance, powers through the toughest going to get the job done faster. Built to shrug off costly snags, cuts, and bruises, the General LCM is the toughest, brawniest workhorse tire in the field. One demonstration will convince you of its tremendous power and capabilities.

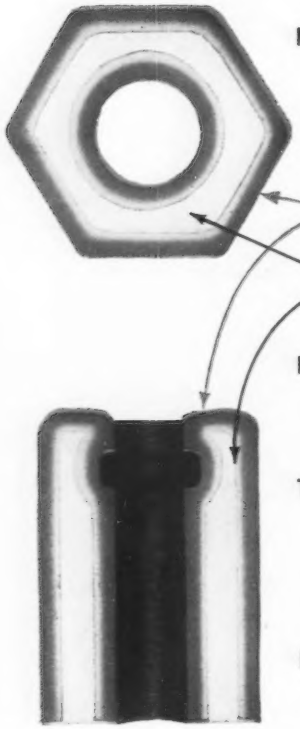
Test it on your toughest job and watch it out-perform anything on wheels!

THE GENERAL TIRE & RUBBER CO.

AKRON, OHIO

GARDNER-DENVER DRILL STEEL

Cuts drilling costs . . . reduces steel breakage



Made like tough rock drill parts

Gardner-Denver sectional drill steel is carburized to produce the same hard case, soft core structure that produces superior rock drill parts. Shot-peening increases fatigue resistance.

High-tensile surface strength resists abrasion, corrosion, nicking and down-the-hole gaff.

Tough, soft core provides compressive strength to withstand shock loads without breaking.

Made from quality steel

Gardner-Denver uses special alloy steels to insure uniform hardening and longer service life.

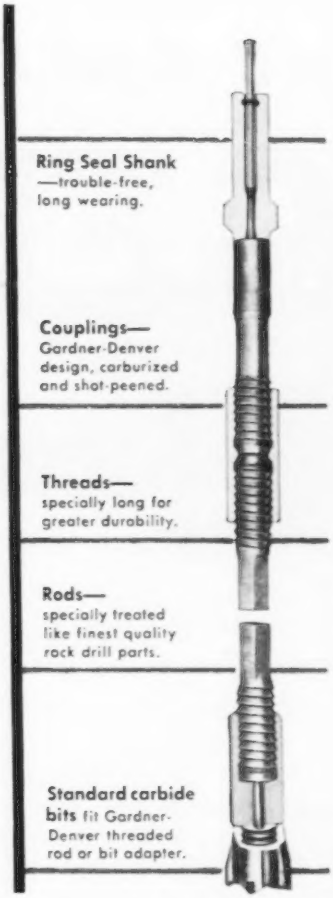
Threads and couplings designed for the job

The extra long threads and couplings of Gardner-Denver design provide greater strength and durability. Couplings are also carburized to provide a hard surface on the threads and a tough core.

Proved on the job

One user drilling hard rhyolite reports steel breakage reduced by 45% after changing over to Gardner-Denver drill steel.

Drill steel represents a large percentage of drilling costs. Gardner-Denver drill steel costs less to use. Write for information.


Ring Seal Shank
—trouble-free, long wearing.
Couplings—
Gardner-Denver design, carburized and shot-peened.
Threads—
specially long for greater durability.
Rods—
specially treated like finest quality rock drill parts.
Standard carbide bits fit Gardner-Denver threaded rod or bit adapter.

Gardner-Denver Sectional Drill Rod Specifications

	CL5-200 Series	CL5-400 Series	CL5-600 Series	CL5-700 Series	CL5-1000 Series
Thread Size	1 1/16"	1 1/4"	1 1/2"	1 3/4"	2 1/2"
Recommended Drill Size	3" and smaller	4" and smaller	4" and 4 1/2"	4" and 4 1/2"	5 1/2"
Recommended Bit Size	1 3/8" to 1 7/8"	2" to 2 1/4"	2 3/8" to 2 3/4"	3" to 4"	4", 4 1/2" and 5"
Rod Sizes	7/8" Hex.	1" Hex.	1 1/4" Hex.	1 1/4" and 1 1/2" Hex.	1 7/8" Hex.
Rod Lengths	2' to 20'	2' to 20'	2' to 20'	2' to 20'	4' to 20'
Coupling Diameter	1 7/16"	1 3/4"	2 1/8"	2 1/2"	3 3/8"
Ring Seal Shank	1" Hex. Collared 1 1/4" Rd. Lugged	1 1/4" Rd. Lugged 1 1/2" Rd. Lugged	1 1/4" Rd. Lugged 1 1/2" Rd. Lugged	1 1/2" Round	2 1/2" Round

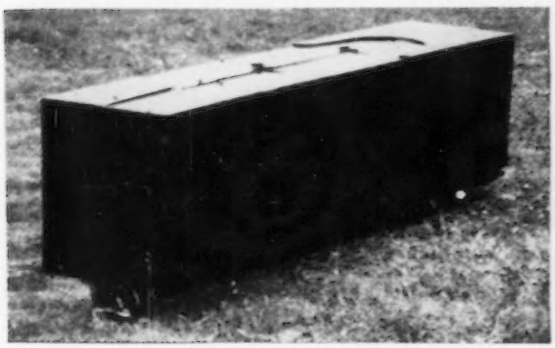
ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois
Export Division, 233 Broadway, New York 7, New York
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

E&MJ NEW PRODUCTS DIGEST

In this issue–the Hunting Harrier, a sonic filter and screen, a kit of exploration case histories from Aero Service, plus a select list of 25 free literature notices on pumps for the mining, and the metal and mineral processing industry. List includes vacuum and pressure pumps for every kind of service. Back side of the For Your Files card lists reprints available from *E&MJ*.



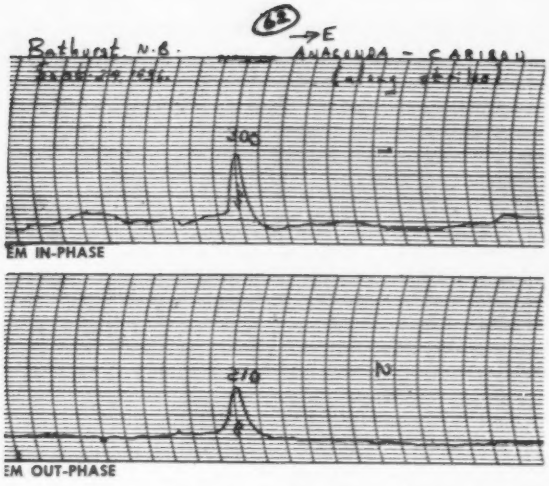
Hunting Harrier Folds Like a Box, Can Hit 60 mph (1)

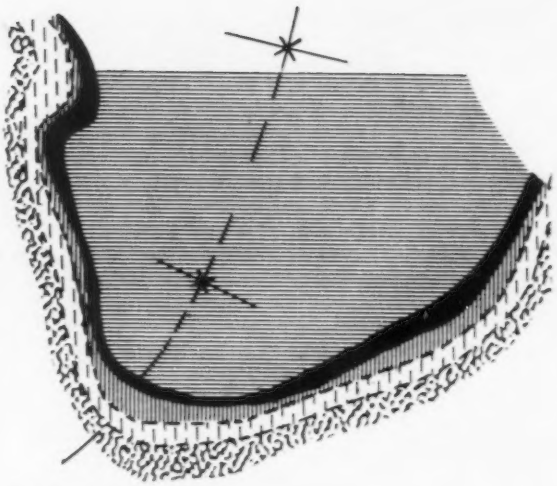
Powered by a 650 cc B.S.A. twin cylinder motorcycle-type engine, the four-passenger Hunting Harrier folds like a box that occupies only 33 cubic ft and can be carried aboard an airplane by four men. Entire assembly weighs only 625 lb. Harrier has four speeds forward, no reverse and is chain driven. Hunting Aircraft Ltd. says that the Harrier can accelerate in a lively manner with four men aboard. Dimensions are—105 in. over-all length; 84 in. wheelbase; 48 in. width; and 24 ft turning radius. Harrier was first developed for military use, but is now available for general use.

Sonic Filters and Sifters Treat Plus 30-Micron Feed (2)

Developed a number of years ago and in use in Europe, the Novo Sonic Filters and Sifters are said to have five times the capacity of conventional machines of the same cloth area. Operating power requirement is said to be ⅓ of conventional machines. In both filter and sifter, the cloth is wire mesh, which when tilted at the proper angle and vibrated functions as a filter or screen cloth. Screening is produced by inducing a low sonic range frequency upon which is imposed a series of harmonics, creating a violent vibrating action with very little flexing of the cloth.

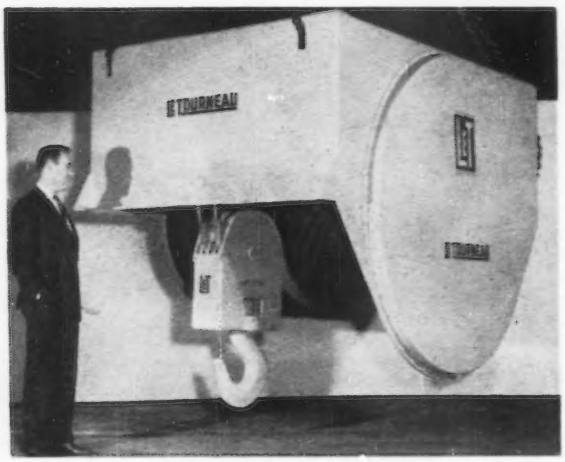
For more information on new products and for copies of the free literature (on p 48 and on the front of the reply card) circle the proper number on the New Products reply card, give your name and address, and mail card to *E&MJ*.





Kit of Case Histories On Airborne Prospecting in New Brunswick (3)

Aero Service Corp. has just released a kit containing case histories on Bathurst-New Castle area airborne exploration. Brief description of the orebody, geophysical results and a plan of the orebody, and charts of the electro-magnetometer (in and out of phase) altimeter, magnetometer and scintillometer readings. Orebodies include Anaconda Caribou, Texas Gulf Sulphur's Half Mile Lake, Heath Steele A and B, Brunswick's orebodies, and graphite bank near 44 Mile Brook camp.

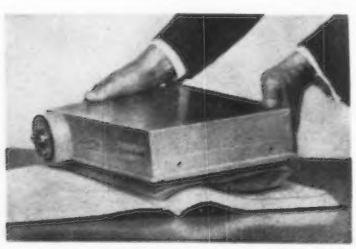


Giant Super-Lift Hoist Developed (4)

An R. G. LeTourneau, Inc. engineer described the latest LeTourneau Gargantua saying that it could lift 20 full-grown elephants to a height of 8 stories. We don't know anybody in the elephant hoisting business, but there are plenty of people who could use a hoist capable of moving 45 tons of peanuts.

Cut Office Automation Down To Size (5)

Royal McBee Corp. has introduced the LGP-30 electronic computer, complete and ready to operate including electric typewriter with paper tape punch. Unit is 26 in. deep by 33 in. high and 44 in. long. Capacity is 4,096 words in the memory drum. Can be used for research problems, market surveys, etc.



Portable Photocopier (28)

Briefcase-sized Contoura-Portable Photocopier can be put face down on the pages of an open book, land records, maps. Follows the page contour clear to the margin to produce crisp black and white copies in 30 seconds. Patented plastic air cushion is key feature that permits such action, says F. G. Ludwig.

Portable Magnetometer (30)

Varian Associates have announced the M-49 portable magnetometer which weighs only 16 lb. Unit is completely transistorized and operates on batteries, which can be recharged on automobile storage battery. Sensing head is a coil of wire wrapped around a bottle containing liquid hydrogen atoms.

Demag Ore Unloaders (31)

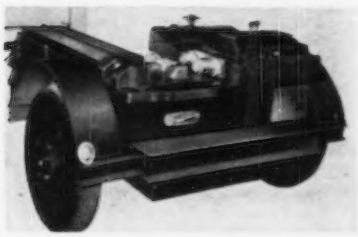
Three Demag slewing jib trolley type ore unloaders, each carrying 33 tons per trip, were installed at Chesapeake & Ohio RR marine terminal at Newport News, Va. Grab bucket can take out 18 tons of ore in 45 seconds from ship's hold.

Safety Aids

Mine Safety Appliances Co.'s goggle cleaning station. **(32)**

High visibility yellow rainwear—jackets, pants, three-quarter and full-length coats, hoods and hats are available from Industrial Products Co. **(33)**

Rubber glove selector charts and pocket guides are available from Pioneer Rubber Co. **(34)**



Portable Track Repairer (35)

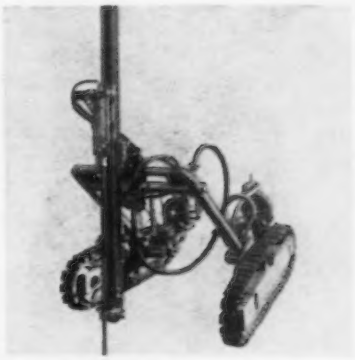
Trackmaster hydraulic pin press, developed by Owatonna Tool Co. can be moved from the repair shop to the yard or mine to make on-the-spot track repairs. Trackmaster uses a 125-ton ram to push pins and bushing through rail. Can be gasoline, diesel, or electric driven.

Mine Car Spotter (36)

Nolan Co. has a new model of the Porta-Feeder mine car spotter (Model ZNCN). Moving and positioning mechanisms and hydraulic jacks are located on the outside of each rail and will handle low belly cars.

Percussion Drills (37)

Chicago Pneumatic Tool Co. introduced three new drills for medium and deep hole work. In hard trap rock, the 4½ in. heavy duty CP-450DR percussion unit can drill 10 ft of 3 in. hole in seven minutes, or 40 ft holes in 34 minutes. CP-400DR can drill 2½ in. holes to 50 ft. CP-400 can drill 3 in. holes to 25 ft. Hole cleaner is air blast.

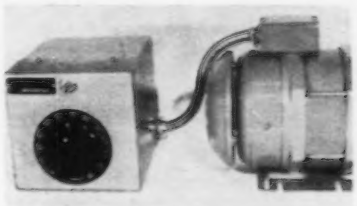


Dual Air Motor Drill (38)

Le Roi LWD-400 Rock Cruiser is a track-type drill powered by two 7½ hp air motors with a U-bar construction that allows toe hole, breast and down hole drilling. Available in 3⅛, 3½ and 4 in. drill sizes.

Aluminum Tamping Pole (39)

Weighing only half as much as wood, Austin Powder Co.'s aluminum tamping pole are nonsparking, nonwarping and virtually indestructible, according to the company.



Motor Speed Control (40)

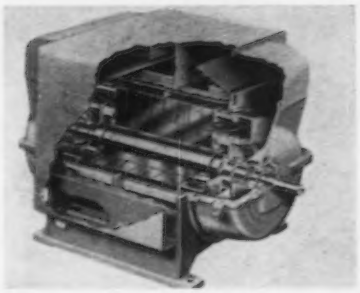
Carpco Mfg., Inc. is producing MRS variable speed drives for dc motors that rectify ac to produce only the amount of power needed to operate the motor —no power is wasted as heat. Smooth continuous control is possible just at the turn of a dial. Available for fractional to 20 hp motors. Dynamic braking and motor reversing are optional features.

Shaker Scalping Screen (52)

Variety of screen cloth can be fitted into the screen box of Syntron Co.'s new scalping shaker for wet or dry feeds.

Measure Microns (53)

Mine Safety Appliances Co.'s particle size analyzer was designed to analyze particles in the 0.1 to 40 micron range. Sample is centrifuged and then measured to determine particle size distribution.



Weather Protected Motors (41)

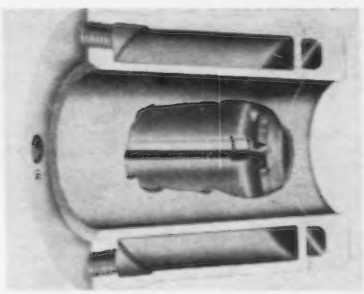
Weather protected motors, manufactured by Louis Allis Co. in ratings from 250- to 1500hp for outdoor use in high wind, driving rain or sand storms.

Concrete Placer (42)

Model CO-10 Airplaco can handle 10 cubic ft of concrete per charge, and Model CP-15 can handle 15 cubic ft. Placing rates from 8- to 20 cubic yards per hour are possible depending on rock size, distance, head and air pressure used according to Air Placement Equipment Co.

Steel Lockers (43)

Penco Metal Products Div., Alan Wood Steel Co. has prepared an 8-page bulletin illustrating its line of steel storage lockers. Twelve styles are available in a variety of sizes.



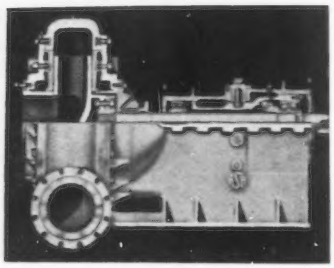
Blast Furnace Tuyere (47)

Tuyere uses copper to provide efficient cooling and was developed by Bethlehem Steel Corp. It is now available in two-piece Eberhardt design from Philadelphia Bronze & Brass Corp.

Continuous Ion Exchange (48)

Newly formed corporation, Chemical Separations Corp., has patent rights to the Higgins continuous ion exchange contactor. In a letter to *E&MJ*, Mr. Higgins says "We think we have an efficient tool for the treatment of unclarified ore leach liquors. . . . We have no routine production units outside of the AEC, but look forward to the opportunity to demonstrate our process."

Literature On Pumps For The Mining & Mineral Processing Industry



Redesigned line of Hydroseal sand and dredge type pumps for handling abrasive solids over 4-mesh are described in Allen-Sherman-Hoff Pump Co. bulletin No. 657. Sizes from 1½ to 14 in. Capacities to 14,000 gpm. 4pp. **(57)**

Rubber-lined pumps for moving abrasive pulps, using clear water backwash—Hydroseal split-shell design by Allen-Sherman-Hoff Pump Co.—are illustrated in 4-page bulletin No. 457. Six sizes from 2 to 14 in. **(58)**

Rubber-lined pumps that operate without sealing water to deliver pulp are illustrated in Allen-Sherman-Hoff Pump Co. bulletin No. 557. Centriseal rubber-lined design. 4pp. **(59)**

Multi-stage horizontally split medium pressure centrifugal pumps from Ingersoll-Rand are described in 6-page release. Designed to handle many fluids, I-R class RT, RTS and RTL pumps have capacities from 200 to 2,800 gpm on heads up to 2,400 ft. 6pp. **(60)**

Designed for metering minute quantities of costly or corrosive fluids, Milton Roy Co.'s line of Minipumps is available in capacities ranging from 300 to 3,940 milliliters per hour. Manual adjustment is possible. **(61)**

Impervious graphite-lined centrifugal pumps for corrosive fluids are presented in Fall Industries literature on Impervite pumps. Six models available with from 25 to 200 gpm capacity on heads from 20 to 100 psi. 8pp. **(62)**

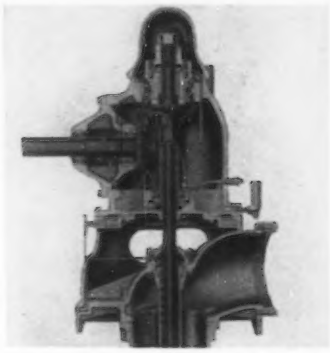
High pressure pumps with working pressures up to 35,000 psi and capacities to 2,000 gph are detailed in Philadelphia Pump & Machine Co. catalog HP-1254. 8pp. **(63)**

Mechanical considerations in pump design is the title of Peerless Pump Div., Food Machinery & Chemical Corp. 8-page bulletin. **(64)**

Power plant pumps (two-stage turbine) for high pressure, hot or cold water, low suction head operation are illustrated in 15-page bulletin No. 107A from Roy E. Roth Co. **(65)**

High pressure pumps operating on the hydraulic pressure exchange principle are discussed in Manton-Gaulin Mfg. Co., Inc. bulletin. Manton-Gaulin also has other bulletins on twin lobe Rotary Positive and Triplex high pressue prumps. 6pp. **(66)**

Slurry and sludge pumps in centrifugal design can be obtained from Lawrence Pumps Inc. according to bulletin No. 207-4. 8pp. **(67)**



Peerless Gearturbo right angle drive pumps for deep well use are described in 8-page bulletin B-140-1 from Peerless Pump Div., Food Machinery & Chemical Corp. **(68)**

Diaphragm slurry pumps, the Oliver design from Dorr-Oliver Inc., are presented in 6-page bulletin. **(69)**

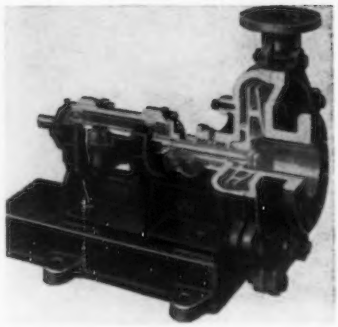
Vacuum pumps—0.05 micron or better—are available from W. M. Welch Scientific Co. according to Duo-Seal Pump bulletin. 14pp. **(70)**

All the various pumps manufactured by Labour Co., Inc. are illustrated in 15 bulletins bound into one catalog and available from the company. **(71)**

Morris Machine Works bulletin No. 185 describes capacities and applications of Morris heavy-duty low-speed RX slurry pumps. **(72)**

High vacuum diffusion and booster diffusion pumps are the subject of a 12-page bulletin prepared by NRC Equipment Corp. **(73)**

Twin-lobe pumps by Manton-Gaulin Mfg. Co., Inc. are described in 12-page bulletin No. TLP-57. Designed for corrosive fluids. **(74)**



Complete line of Mission Mfg. Co. centrifugal pumps is illustrated in company literature. Available in sizes from 1 to 6 in. discharge for abrasive pulp service at up to 2,000 gpm on heads to 400 ft. **(75)**

Gear pumps for handling solutions and solvents are available. Gearex pump line from Sier-Barh Gear & Pump Co. Company also makes screw pumps. **(76)**

Diaphragm pumps for controlled volume pumping of fluids are available from Lapp Process Equipment Div., Lapp Insulator Co., Inc. Bulletin 440 describes Lapp Pulsafeeders for corrosion service for theoretical capacities from 1.6 to 339 gph at 0 psig. High pressure models have capacities from 1.6 to 84.5 gph at 0 psig. **(77)**

Microflo Pulsafeeders are also available from Lapp Insulator according to bulletin 500. Capacities are 1,040 and 2,300 milliliters per hour. Flow rates are adjustable over a wide range. **(78)**

SRL vertical sump pump by Denver Equipment Co. is available in sizes from 2x2 to 6x6 in. with capacities from 20 to 1400 gpm. **(79)**

Duplex diaphragm pumps Type SP developed by T. Shriver & Co., Inc. can be had in 20 to 50 gpm at 100 psi head for handling slurries. **(80)**

Type BC general purpose end suction pumps can be obtained from Aurora Pump Div., New York Air Brake Co. Pumps are suitable for circulating, cooling, condensate return, hot water, filters, etc. **(81)**

Diesel Engines For Generators And Earthmovers

Turbo-superchanged opposed-piston diesel engines with up to 3600hp are now available from Fairbanks, Morse & Co. Company says supercharging adds 50% to the engine's capacity and offers a 5 to 10% fuel saving. Units are 6 or 12 cylinder design. **(24)**

Allis-Chalmers Mfg. Co. has introduced two diesel power units for on-the-job use—Model D-344 (88hp) and Model D-516 (131hp). Smaller model is four cylinder, larger is six. Starter is 24 volt electric. **(25)**

Euclid Div., General Motors Corp., says that Cummins 220hp engines are now available in Euclid's R-18 dump truck. R-18 has 5-speed transmission and hydraulic booster steering. **(26)**

Both the standard and heavy models of the Pneumatractor and the Pneumatractor Rotadrill of Schramm, Inc. are now equipped with diesel engines using the gasoline starter principle. **(27)**

For Your Files

This selected manufacturers' literature is free unless otherwise specified. If item is for sale, send request and money direct to manufacturer.

TRACTOR SCRAPERS from Clark Equipment Co. are described in 24-page catalog. **(87)**

PRODUCTION equipment for modern mining is the title of International Harvester Co. literature on earthmovers and drills. 16pp. **(88)**

CONTROLLED speed systems, an 8-page booklet from U. S. Electric Motors, Inc., describes many installations for controlled, automatic variable speed selections. **(89)**

HOW TO choose insulating cable, prepared by Okonite Co., includes a check-list of the many points to be investigated in specifying an electric circuit. 20-page booklet. **(90)**

STORAGE and lubrication of wire rope, bulletin No. 103, may be obtained from Leschen Wire Rope Div., H. K. Porter Co., Inc. **(91)**

CRUSHING, a common hazard of wire rope, is discussed in 4-page release from Leschen Wire Rope Div., H. K. Porter Co., Inc. **(92)**

V-BELTS in the Dixlink construction are illustrated in 4-page bulletin from R. & J. Dick Co., Inc. **(93)**

VIBRATING SCREENS, Allis-Chalmers Mfg. Co. Low-Head line, are presented in 24-page booklet. **(94)**

SCREENS, gyrating, Simpli-Flo and horizontal vibrating types from Simplicity Engineering Co. are illustrated in 30-page catalog. **(95)**

ELECTRIC VIBRATORS from Syntron Co. are detailed as to construction and application according to bin design in 12 pages. **(96)**

VIBRATORY FEEDER catalog from Syntron Co. thoroughly illustrates applications and the company's line of equipment in 32 pages. **(97)**

BELT CONVEYOR manual No. 909 is now available from Jeffrey Mfg. Co. Manual covers conveyor design, construction and belt selections. **(98)**

TIMING BELT DRIVES catalog TB-58 is available from Morse Chain Co. Illustrated in 68 pages. **(99)**

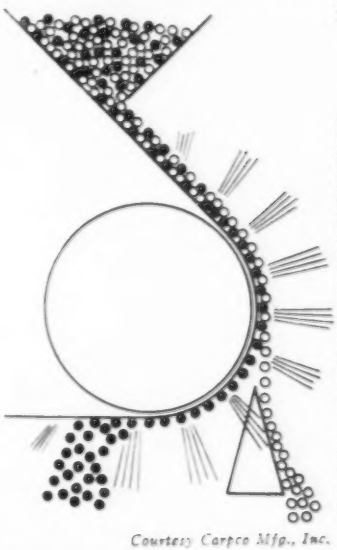
WELDING DIRECTORY of annual electrodes, from Lincoln Electric Co., contains 12 pages of ideas and tables. **(100)**

COUNTERFLOW COOLING TOWERS are illustrated and described in J. F. Pritchard & Co. literature. 14pp. **(102)**

WET CYCLONES from Heyl & Patterson, Inc. are discussed with drawing and tables of results in 16-page bulletin (brochure No. 1157). **(103)**

MACHINERY from Nordberg Mfg. Co. is presented in bulletin No. 271. 11pp. **(104)**

WET CLASSIFICATION, a revised catalog covering classifiers, Hydro-Separators, washers and heavy media separators, is available from Hardinge Co., Inc. One section is devoted to the new Hardinge Overdrain Classifier, a belt-type unit. 24pp. **(105)**



Courtesy Carpco Mfg., Inc.

ROTATING FIELD permanent magnetic separators from Carpco Mfg., Inc. are introduced in 2-page flier. **(106)**

OPTICAL PARTS from Bausch & Lomb can be examined in catalog No. L-117. 17pp. **(107)**

FLOW OF COAL IN BINS, a paper prepared by F. D. Cooper and J. R. Garvey for Bituminous Coal Research, Inc. is available. **(108)**

FLUID ENERGY grinding mill, the Sturtevant Mill Co. Micronizer, is presented in 4-page bulletin. **(109)**

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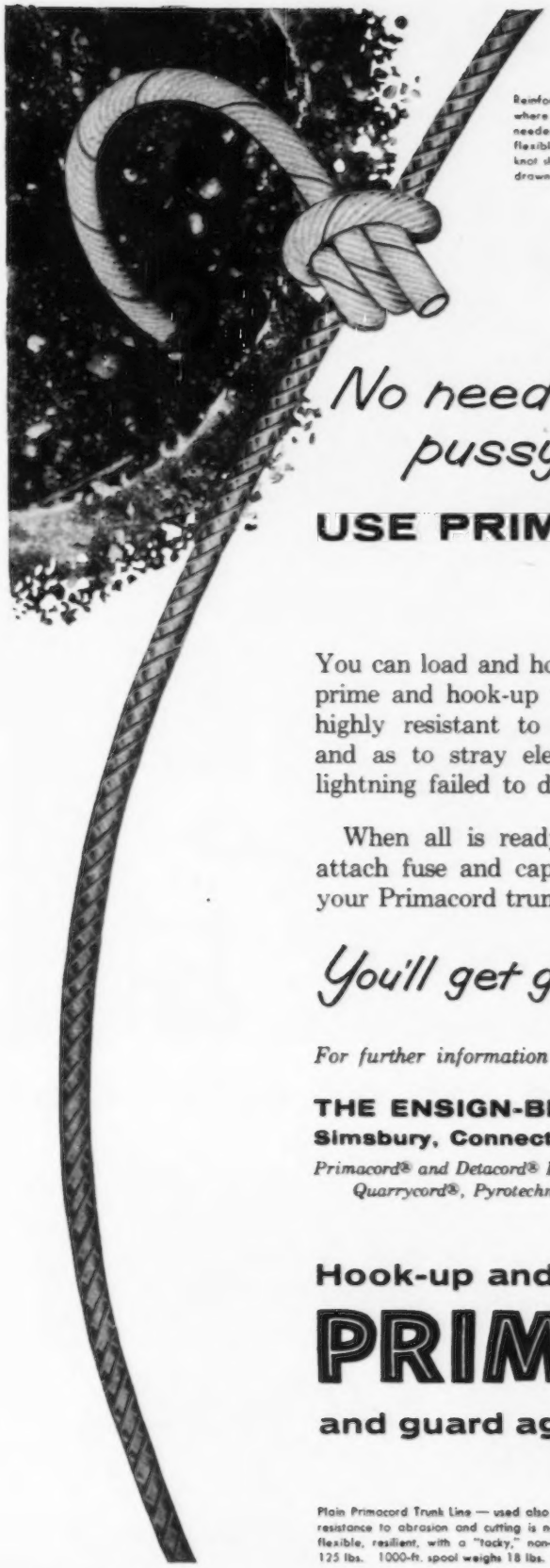

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Plain Primacord Trunk Line — used also for shallow holes — wherever resistance to abrasion and cutting is not required. Textile covered, flexible, resilient, with a "tacky," non-slip surface. Tensile strength 125 lbs. 1000-ft. spool weighs 18 lbs.

P-c

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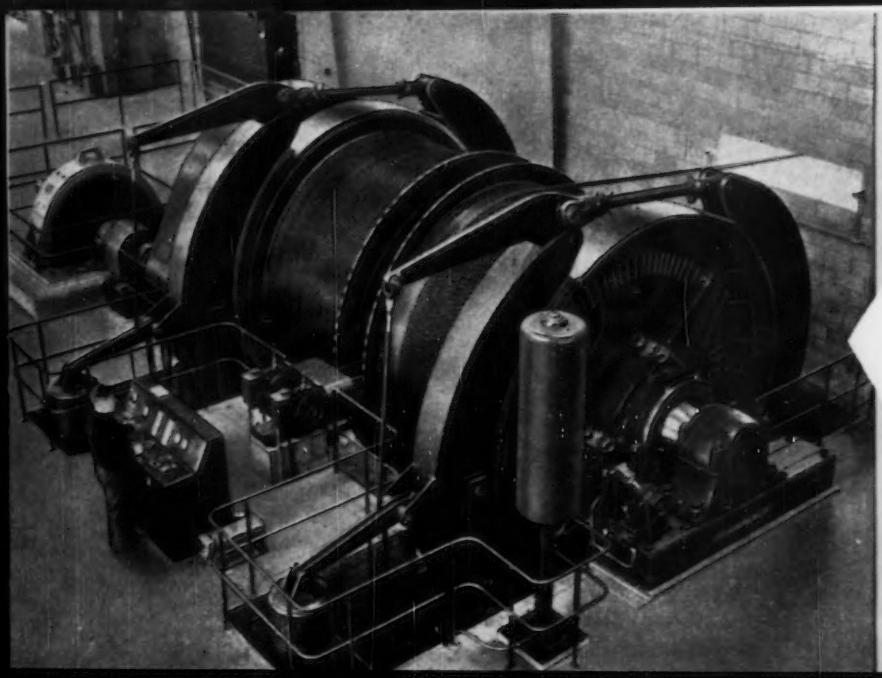


CONVENTIONAL DRUM HOISTS

Typical of the large hoisting machinery built by Nordberg is this conventional 12′ diameter by 84″ face double drum ore hoist which serves a prominent iron producer. This hoist is designed for a depth of 2800 feet, using 10-ton skips and hoisting 14 long tons of ore at a rope speed of 2000 feet per minute.

Nordberg hoists are available for manual, push-button semi-automatic, or fully automatic control.

NORDBERG'S 61 YEARS of MINE HOIST EXPERIENCE can help you select the best hoist to meet your requirements

▶ Why not let over half a century of specialized mine hoist experience help you select the *right* type and size hoist to meet your specific operational requirements?

With the trend toward larger tonnages and more powerful hoists, greater emphasis must be placed on the proven experience and ability of the hoist manufacturer. Here, Nordberg has an established reputation second to none, and can furnish both conventional and friction type hoists. This wide experience is at the call of mine executives everywhere. *Consult Nordberg on your next hoist problem.*

FRICTION TYPE HOISTS

Where applicable, the hoisting of ore, men or materials can be economically handled with Nordberg Friction Hoists . . . built for either counterweighted skip or skips-in-balance operation. Manual, push-button semi-automatic, or fully automatic control available. Outstanding features of the Nordberg design include: One-piece welded steel drum; anti-friction roller bearings throughout; pressure applied—pressure released hydraulic brakes with emergency gravity application.

Illustrated is a 4-rope hoist designed for push-button semi-automatic, multi-level operation, to handle men and material.

NORDBERG

MINE HOISTS

NORDBERG MFG. CO.
Milwaukee 1, Wis.

© 1957, Nordberg Mfg. Co. MH157

Longyear mobile rigs moved and set up at new hole in hours

Moving heavy pieces of equipment and erecting tripods is tough work that uses up valuable drilling time. Longyear mobile rigs help diamond drillers avoid this and keep their drills operating more of the time.

Here are three ways Longyear Mobile Rigs save time, effort and money wherever terrain permits their use.

1 Modern steel masts eliminate the need to haul or erect heavy materials for tripods.

2 Pumping unit and other equipment can be mounted on the truck, trailer or jeep, eliminating inconvenient and time-wasting handling.

3 On some truck models, drill and pump may be powered by the truck engine, eliminating the need of separate power units.

Mobile-mounted Longyear drill rigs are engineered to the tough specifications of expert drillers—as are pumps, diamond bits, and all other component parts of Longyear *Coordinated Systems* for diamond drilling.

Write to E. J. Longyear Company, 76 South 8th Street, Minneapolis, for complete details on how Longyear mobile drill rigs can cut costs and save time for you.

E. J. LONGYEAR COMPANY
76 South 8th Street • Minneapolis 2, Minnesota
CANADIAN LONGYEAR, LTD., NORTH BAY, ONT
LONGYEAR, N.V., THE HAGUE, HOLLAND
LONGYEAR ET CIE., PARIS, FRANCE

Diamond Core Drill Manufacturers • Core Drilling Contractors
Mining Engineering and Geological Consultants

Longyear

THE WORLD IS OUR WORKSHOP

No. 4 in a series

Right off the Wire

Power for earth satellites could be supplied by a new chemical battery that uses a dye to convert sunlight into electricity.

A new bearing metal of tin and aluminum is said to combine the bearing qualities of one with the light weight of the other.

Negatively ionized air is being used as a painkiller for patients with severe burns. After two exposures of twenty minutes each no narcotics are needed.

Users of High Voltage cables should note that high molecular weight polyethylene can be expected to have a voltage life about seven times that of standard polyethylene. (From paper on Dielectric Strength and Voltage Life of Polyethylene, presented at AIEE Winter General Meeting, February 1958, by Messrs. Hunt, Ware and Koulopoulos of Simplex.)

A new, automatic door opener is installed overhead, like a door check, and requires no complex, under-floor wiring. It can be installed in a few hours.

In a new cook stove the heat is generated in the utensil by putting it in a magnetic field. No heat is wasted and spilled food does not burn. It is said to be faster than ordinary electric stoves.

The "cage zone" melting system has proved successful in purifying niobium. Under high vacuum the metal is melted by high frequency current and the impurities separate to be cut off later.

A vinyl lining material for swimming pools of masonry or wood is in the form of sheeting with an adhesive back that sticks to the sides and assures complete waterproofing.

To meet the growing demand for power by industry, Simplex has installed new equipment that allows cable cores of greatly increased diameters to be armored with CONDEX, the interlocking armor tape made by Simplex since 1924.

Printed pages can actually be made to talk by means of a Japanese invention. The back of the paper is treated like magnetic tape and produces recorded sounds when a reproducing head is passed over the printed words.

Further information on these news items and on Simplex cable is available from any Simplex office. Please be specific in your requests.

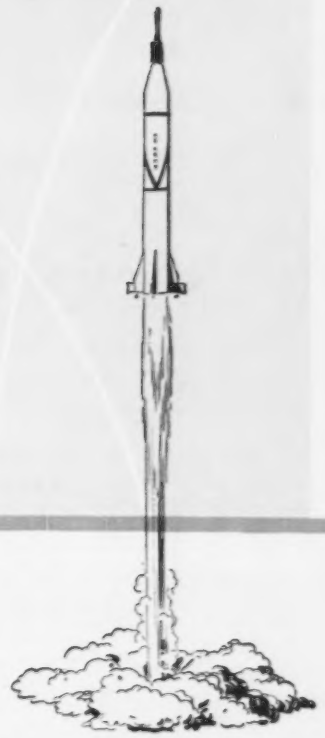
A new, thirty-nine-passenger bus for intercity service is claimed to have many advantages. It has a flat floor (no step-up to seats), a "recreation area," lavatory, reclining seats and air suspension.

The size of electrical components may be further reduced by a process for putting tiny germanium transistors into printed circuits.

Buildings are being erected with the use of balloons instead of derricks.

A method of projecting color pictures on a screen from black and white slides has been discovered.

An acknowledged leader of the cable industry in research and manufacturing skills, Simplex scientists and engineers present technical papers on a variety of subjects of interest to users of insulated cables. A list of papers read before the AIEE and other associations will be sent on request.



Underwater nerves take the "miss" out of missiles

Test rockets fired from the U. S. Air Force Test Range in the Bahama Islands are tracked electronically from a series of check points along their routes. This close observation detects the slightest variance from the missiles' intended flight path. The vital communications link for this work is a 1400-mile Simplex submarine cable to Puerto Rico — a product of the world's most modern techniques in under-water cable manufacture.

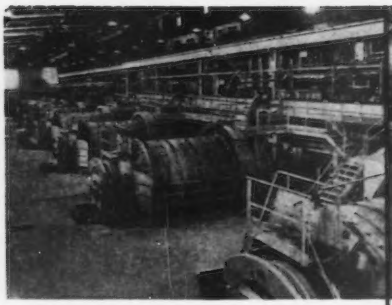
For high voltage power transmission or the most exacting communications cables, Simplex' research, engineering and manufacturing facilities are at your service.

SIMPLEX WIRE & CABLE CO.
Cambridge, Massachusetts and
Newington, New Hampshire

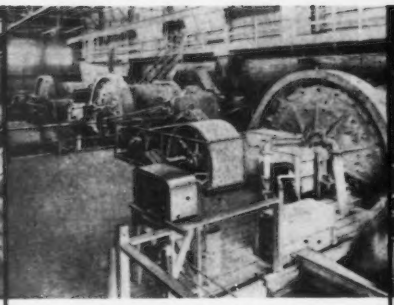
Simplex

Highest quality cables for: Mining
Power & Lighting • Construction
Transportation • Communications
Signalling

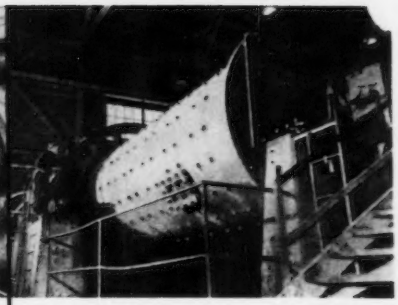
"the American manufacturers of transoceanic telephone cables"



This large copper company has 17, 9½'x 12' and three 10'x 14' Marcy Open End Rod Mills; three 8'x 12' and three 10'x 12' Marcy Grate Discharge Ball Mills.



Three 8'x 9' Marcy Grate Discharge Ball Mills in a large copper mill.

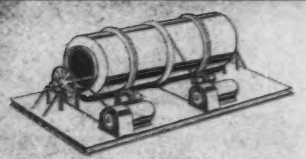


This 8'x 20' Marcy Pebble Mill is one of 21 Marcy Mills used by a molybdenum company.

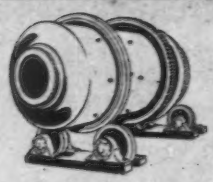
Marcy Grinding Mills

- grate discharge ball mills, open end rod mills, tube mills, pebble mills, center and end peripheral discharge rod mills, acid-proof mills, batch mills.
- for metallic and non-metallic ores, cement, specification sands, clay, fibrous material.
- wet or dry grinding.
- 29 different diameter sizes, from 12" to 12'6" inside diameter, are operating and proved in the field.
- grind material 1½" or finer to a product as fine as 325 mesh.
- capacities up to 6650 tons per 24 hours.

Other Products

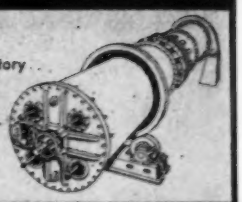


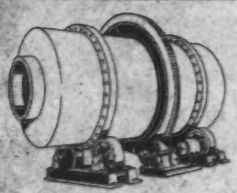
Custom Engineered Pug Mills.



Custom Engineered Leaching Drums.

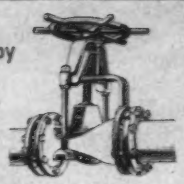
Burt Filters.
30"x 72" Laboratory Unit, and 5'x 40' Standard Commercial Size.

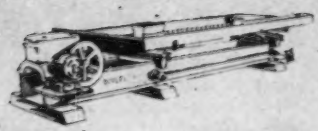




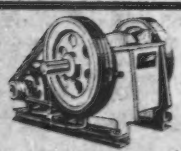
Custom Engineered Fusion Furnace.

Massco-Grigsby Pinch Valves.
1" to 14" dia.

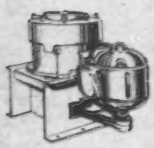




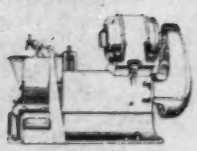
Wilfley Concentrating Tables.
Laboratory and Commercial Sizes.



4"x 6" Massco Laboratory Jaw Crusher.



6" and 10" Massco Gy-Roll Reduction Crusher.



Massco-McCool Pulverizer.

Marcy Direct Reading Pulp Density Scale.

THE MINE AND SMELTER SUPPLY CO.

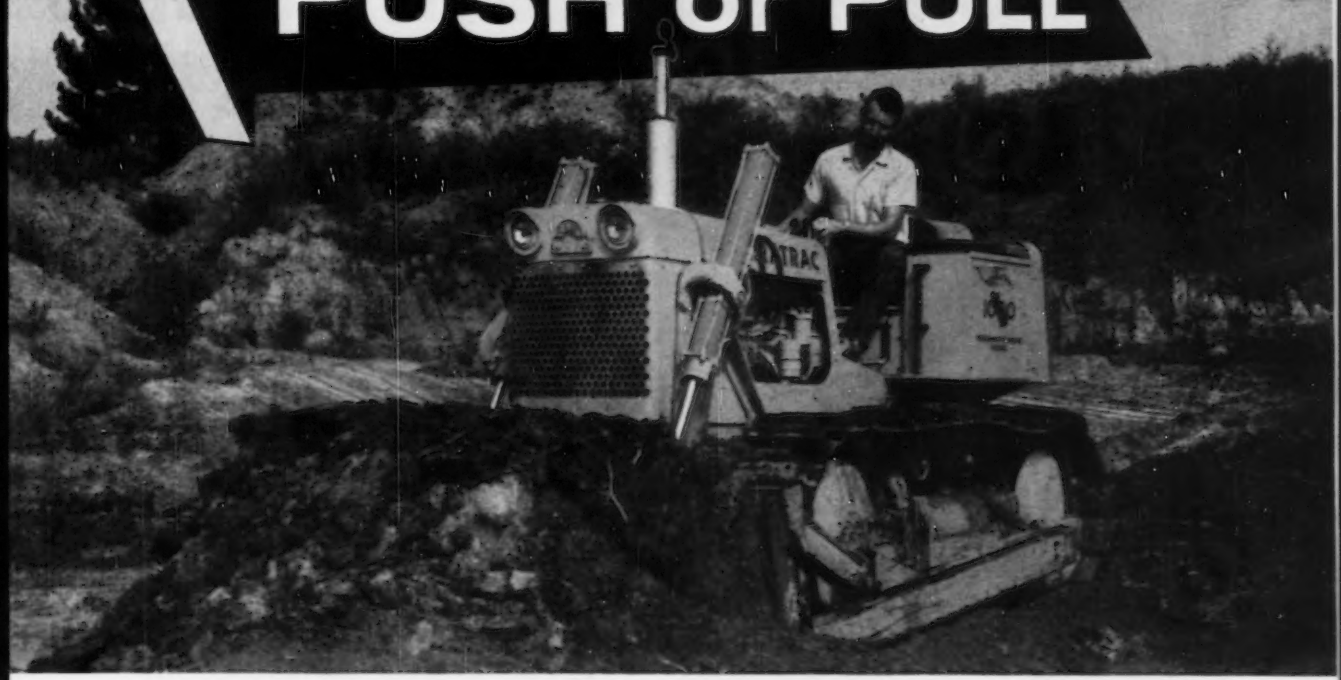
DENVER 16, 3800 RACE — NEW YORK 17, 122 E. 42ND ST. — SALT LAKE CITY 1, 121 W. 2ND S. — EL PASO, P. O. BOX 1162

SALES AGENTS AND LICENSED MANUFACTURERS THROUGHOUT THE WORLD

MARCY®

24,000 LBS.

PUSH or PULL



Here's EXTRA POWER for bulldozing, winching, towing—at a much LOWER PRICE than you'd expect to pay!

When it comes to effective work-power, comparative tests prove the new 100 HP Case® TerraTrac® Model 1000 diesel, with power-boosting torque-converter drive, can outpull any conventional tractor in its price range — *bar none!* These same tests also prove the "1000" is far ahead of the field in maneuverability and ease of handling because it is the *only* crawler in its class with a *modern* hydraulic power-shift transmission *plus* 3-way power-steering. Result — contractor-owners find it easier to attract and hold good operators because they can *do twice as much work with 90% less effort.* For free demonstration and details of new Case LEASE and financing plan, just mail handy coupon at right.

CASE®

1st in quality for over 100 years

Clip . . . Mail for demonstration proof

Also exclusive with TerraTrac!

- **Power-tilting blade** — You just flip two hydraulic levers to tilt bulldozer 14" right or left—for ditching, crowning roads, cutting tree roots, breaking through hard ground, etc.
- **Higher working speeds** — From 0 to 6.0 MPH forward; 0 to 7.0 MPH reverse — plus infinite number of in-between speeds, automatically balanced to changing loads by torque converter. Engine stalling is completely eliminated.
- **Instant power-shifting** — From high to low speeds — and from forward to reverse. No clutching or stopping to shift gears.
- **Full power-steering** — Independent power control of each track, with finger-tip hydraulic controls, increases maneuverability . . . makes operation easy as driving a modern car.
- **Torsion bar track suspension** — Smooths out bumps, maintains full traction on both tracks at all times — regardless of irregularities in ground surface.

J. I. CASE CO., Dept. D1378 Racine, Wis., U.S.A.

☐ Send full details on TerraTrac "1000" tractor with ☐ Dozer ☐ Winch.
☐ Tell me where I can see one in action.

Name .....
Title .....
Company .....
Address .....
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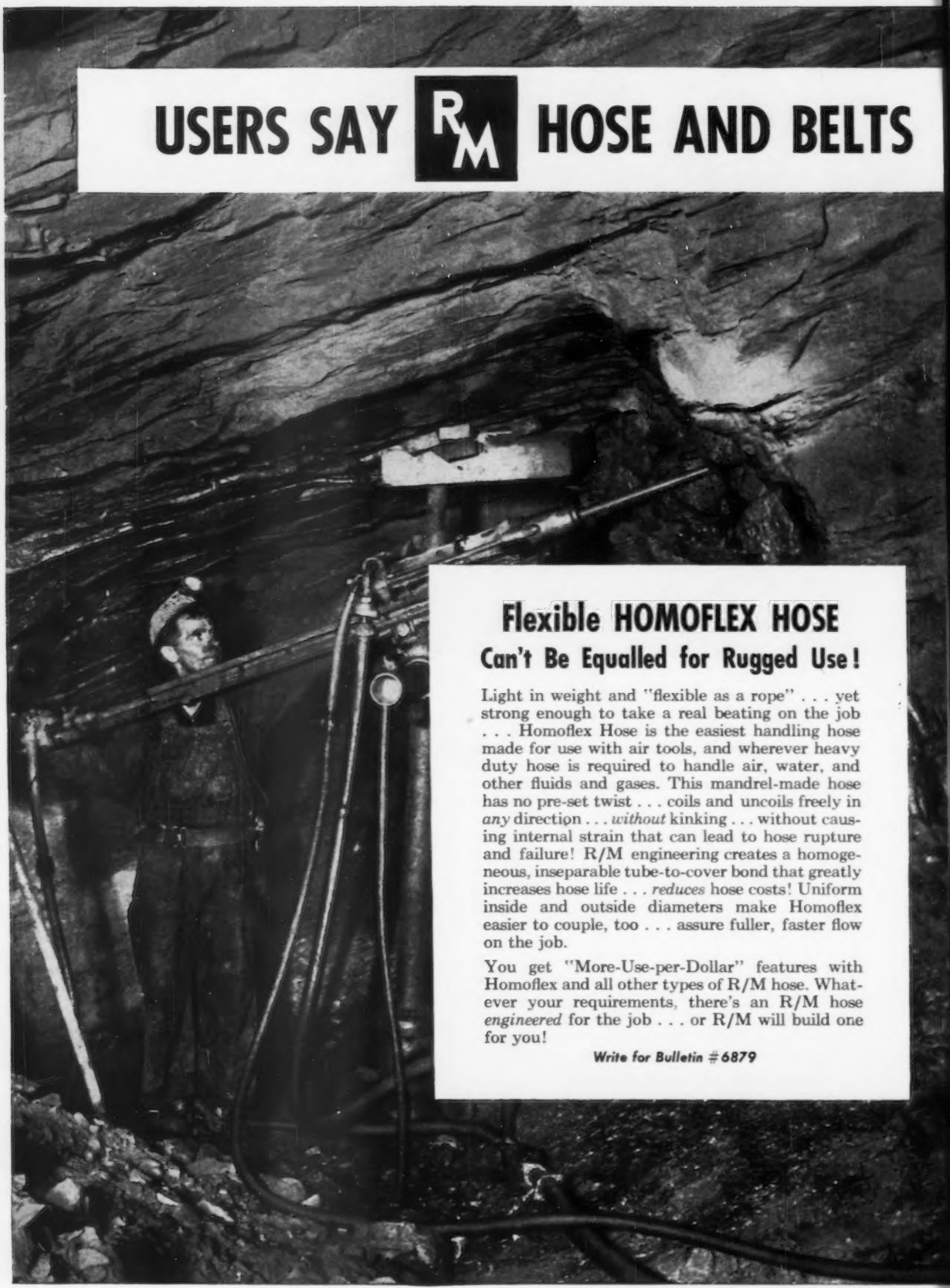
CT-D-125

INDUSTRIAL WHEEL AND CRAWLER TRACTORS • LOADERS • DOZERS • BACKHOES • ENGINES

USERS SAY R/M HOSE AND BELTS



Flexible HOMOFLEX HOSE

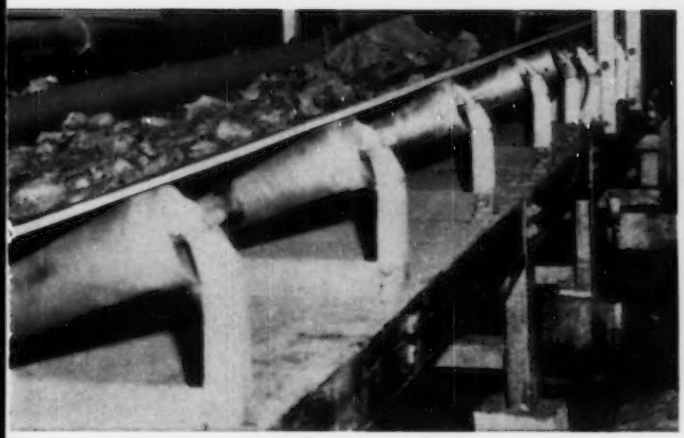
Can't Be Equalled for Rugged Use!

Light in weight and "flexible as a rope" . . . yet strong enough to take a real beating on the job . . . Homoflex Hose is the easiest handling hose made for use with air tools, and wherever heavy duty hose is required to handle air, water, and other fluids and gases. This mandrel-made hose has no pre-set twist . . . coils and uncoils freely in *any* direction . . . *without* kinking . . . without causing internal strain that can lead to hose rupture and failure! R/M engineering creates a homogeneous, inseparable tube-to-cover bond that greatly increases hose life . . . *reduces* hose costs! Uniform inside and outside diameters make Homoflex easier to couple, too . . . assure fuller, faster flow on the job.

You get "More-Use-per-Dollar" features with Homoflex and all other types of R/M hose. Whatever your requirements, there's an R/M hose *engineered* for the job . . . or R/M will build one for you!

Write for Bulletin #6879

GIVE YOU "*More Use per Dollar*"



RAY-MAN CONVEYOR BELT ...Lowest Cost per Haul!

Cushioned strength members . . . *double* compensation to relieve stress on outer plies . . . strength *plus* flexibility to carry bigger loads and resist ripping, *last* longer! Ray-Man requires no breaker strip . . . *holds* fasteners . . . is mildew-proof and moisture resistant. Exclusive "XDC" Cover increases protection against wear, tears, cuts and abrasion. Check "More-Use-per-Dollar" features of Ray-Man and other R/M feature conveyor belts, such as Homocord for unusually abusive shock loading, and R/M Tension-Master for long lifts, high tensions.

Write for Bulletin # 6915

R/M POLY-V® DRIVE Saves Space...Eliminates Belt Matching Problems

Single unit belt across full width of the drive sheave . . . *not* an assembly of V-belts . . . gives patented Poly-V high V-groove grip *plus* flat belt strength . . . *twice* the tractive surface to deliver up to 50% *more* power in the same space as V-belt drives—equal power in ⅔ the space! Your multiple-belt "length matching" problems are ended . . . equipment downtime and belt replacement costs are cut to a minimum! Belt and sheave inventories are cut, too . . . because just *two* cross sections of Poly-V Belt meet *every* heavy duty power transmission requirement. Let R/M engineers help determine the best Poly-V* Drives for your mine fans and other equipment.

Write for Bulletin # 6638

**Poly-V is a registered Raybestos-Manhattan trademark.*

And . . . for the "Smoothest Running V-BELTS Made" Specify CONDOR and R/M SUPER-POWER V-BELTS

RM-713

BELTS • HOSE • ROLL COVERINGS • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products: Abrasives and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

New Flood Control Tunnel Near Boston

Some 40,000 cu yd of medium-hard argillite, with diabasic intrusions, had to be removed in driving a 5266-ft flood control tunnel beneath Malden, Mass., north of Boston. Bethlehem Hollow Drill Steel, 1⅛ in. round, helped to speed the boring of the blast holes.

The 12½-ft-diameter tunnel is being built for the Commonwealth of Massachusetts, Metropolitan District Commission, Construction Division, by Coker Construction Co. The tunnel is about 300 ft below ground level, and at its extremities, connects two vertical shafts. Upon completion, it will divert Spot Pond Brook through an inverted siphon beneath the city.

Bethlehem Hollow Drill Steel keeps costs down in all kinds of rock removal because it stays on the job. Rolled from fatigue-resistant steel, it has a uniform hole which is centrally located in the bar. Bethlehem Hollow has a wide quenching range. And it is easy to heat-treat for the proper balance of toughness and wear-resistance, providing long-wearing threads and strong shanks.

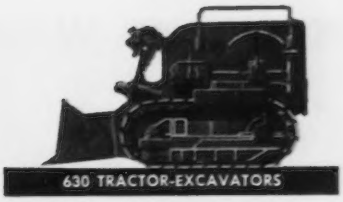
Bethlehem Hollow can be obtained in Carbon and Ultra-Alloy grades in rounds, hexagons and quarter-octagons. It comes regularly in lengths of from 18 ft to 27 ft, though longer lengths can also be furnished. Specify Bethlehem Hollow the next time you need drill steel.

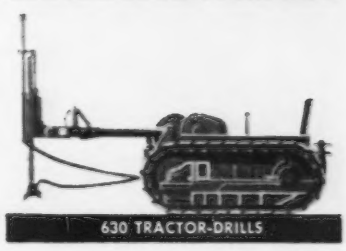
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM HOLLOW DRILL STEEL CARBON AND ULTRA-ALLOY

BETHLEHEM STEEL





Eimco 630 Series...RUGGED-DEPENDABLE

Eimco 630's with their many patented features provide unusual ruggedness and dependability that is exclusive with Eimco equipment.

Low operating and maintenance costs with high production and unequaled maneuverability make the 630 the preferred machine for underground trackless operation in rock headings and tunnels.

Hundreds of 630's in operation as excavators, bulldozers, transports and other variations have shown a lower cost per ton moved, transported or loaded than any previous equipment.

For low cost material handling of this type, write Eimco for more detailed information. There is an Eimco for every loading operation underground.

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

New York, N. Y. Chicago, Ill. San Francisco, Calif. El Paso, Tex. Birmingham, Ala. Duluth, Minn. Kellogg, Ida. Pittsburgh, Pa. Seattle, Wash.
Cleveland, Ohio Houston, Tex. London, England Gateshead, England Paris, France Milan, Italy Johannesburg, South Africa

B306

KOEHRING WORK CAPACITY *in action...*

Swings a big bucket — Notice the size of this dragline, stripping a coal seam in an Eastern mine (below). It's the big Koehring 1205 — and handles 3 to 4-yard bucket, depending on weight of materials. Boom lengths: 60 to 170 feet. This big-capacity stripper also converts to 3-yard shovel. High-lift model has a 3-yard dipper on 40-foot shovel boom — or a 2½-yard dipper on 50-foot shovel boom.

21.5 mph Cruiser® — One man controls all operations, one engine supplies all power for work and travel on Koehring 205 Cruiser crane. There's a full range of low working speeds up to 7 mph — plus travel speeds up to 21.5 mph. It has smooth torque-converter drive, power steering, 27½-foot turn radius, 30% gradability. Usefulness is unlimited in mines, pits, and quarries. 205 Cruiser lifts up to 15 tons — handles ½ to ¾-yard clamshell or dragline buckets on a wide work radius — converts to ½-yard shovel or hoe.

Ship to shore — A pair of Koehring 405 clamshell cranes, mounted on a Great Lakes dredge — one of the world's largest — solved the problem of transferring sand from the ship's hold to shore. With this system, approximately 4,500 tons of sand are unloaded in 6 hours. Crane in foreground dumps into a Johnson Lo-Bin, mounted on flanged wheels. Lo-Bin travels along track, transports sand to a swinging, boom-type conveyor, which stockpiles it at dockside. On clamshell work, Koehring 405 handles 1 to 1½-yd. buckets. Check its other capacities in chart on opposite page.

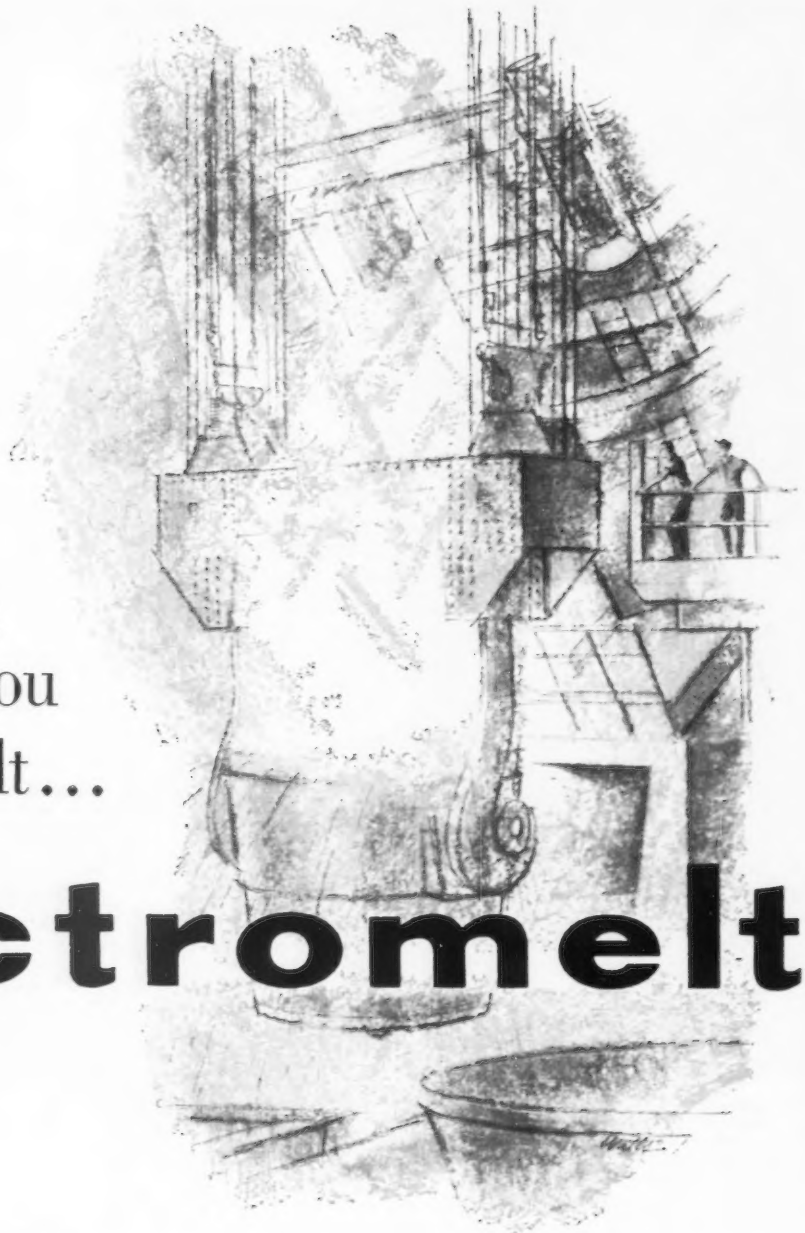
KOEHRING DIVISION OF KOEHRING COMPANY, Milwaukee 16, Wis.

Here are some figures that will interest you:

KOEHRING MODEL	SIZE DIPPER	LIFT CAPACITIES (Crawler ratings based on 75% of tipping load. Rubber-tired machines — 85% of tipping load.)	
205 CRAWLER	½-Yd.	20,000 lbs.	at 10-ft. radius
205 ON RUBBER	½-Yd.	30,000 lbs.	at 12-ft. radius
305 CRAWLER	¾-Yd.	30,000 lbs.	at 12-ft. radius
305 ON RUBBER	¾-Yd.	50,000 lbs.	at 10-ft. radius
405 CRAWLER	1-Yd.	40,000 lbs.	at 12-ft. radius
445 ON RUBBER	(Crane only)	90,000 lbs.	at 15 ft. radius
605 CRAWLER	1½-Yds.	72,300 lbs.	at 12-ft. radius
805 CRAWLER	2-Yds.	104,200 lbs.	at 12-ft. radius
1205 CRAWLER	3-Yds.	190,000 lbs.	at 12-ft. radius

Want more information? See Koehring distributor.

In heavy rock — Owner of this Southern mine needed a heavy-duty shovel to strip rocky overburden — picked a Koehring ¾-yard 305 for the job. Its powerful digging crowd, and rugged strength of deep-section boom and dual dipper sticks, proved more than a match for the heavy rock. Yet, in work like this, 90% power-assist on main drum clutches gives operator a light lever-pull and sensitive "feel" of load. Power, strength, stability as a shovel increase the 305's work capacity with all attachments. For proof, check its lift ratings (at left).



When you melt...

Lectromelt*

McGRAW EDISON

In the United States

Lectromelt Furnace Division, McGraw-Edison Company
322 32nd Street, Pittsburgh 30, Pennsylvania.

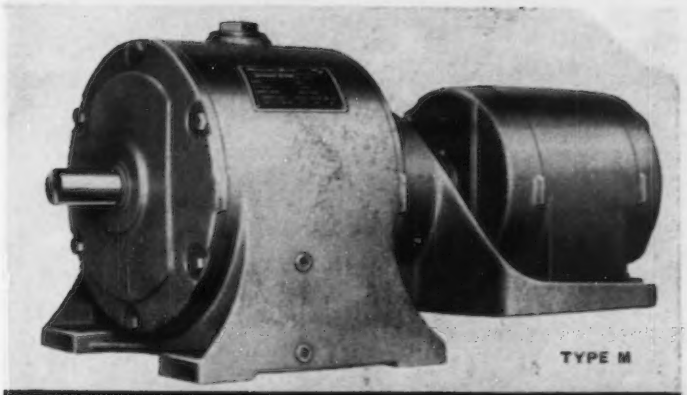
and around the World

Forni Stein—*Genova, Italy*
Canefco Limited—*Toronto, Canada*
Electric Furnace Company, Ltd.—*Weybridge, England*
Demag-Elektrometallurgie, GmbH—*Duisburg, Germany*
General Electrica Espanola—*Bilbao, Spain*
Stein et Roubaix—*Paris, France*
S. A. Stein & Roubaix—*Bressoux-Liege, Belgium*
Daido Steel Co. Ltd.—*Nagoya, Japan*

Catalog 10 describes efficient, time-proven Lectromelt furnaces and equipment.

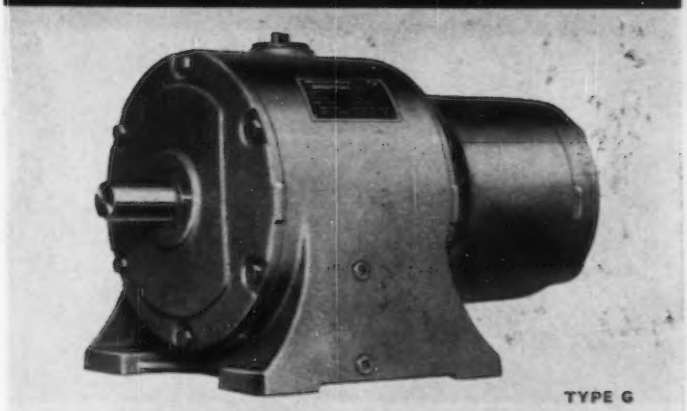
MARKETING BULLETIN

Important Gearmotor Announcement



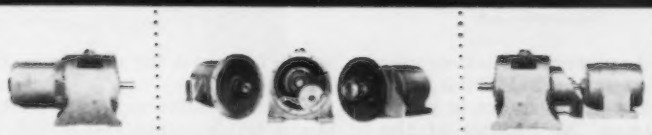
TYPE M

Customer-proved and -preferred advantages of this Western Gear all-motor gearmotor include: easy motor replacement; straddle-mounted high speed pinion for precision alignment; balanced heat treat to ensure long life; extra large inspection cap that eliminates removing end bells for inspection.



TYPE G

Utmost compactness is the first obvious advantage of the Western Gear integral gearmotor. Other superior points include: shank-type pinion that provides maximum strength and concentricity; precision-machined adapter that assures accurate alignment; double output shaft seal to keep oil in and foreign materials out; wide bearing spacing allowing maximum overhung loads.



Western Gear integral and all-motor gearmotors are companion products which may be converted, right in the field, simply by interchanging motor packages. Ratios changed easily and quickly, too, with no special tools. This unique advantage is of greatest importance when unforeseen requirements for different speeds or motor packages arise in the field.

Western Gear now marketing own line of gearmotors, products of 25 years of proved and preferred production for major motor manufacturers.

Western Gear Corporation announces the design, manufacture and marketing of its line of StraitLine integral and all-motor gearmotors ranging from 1 to 60 HP and from 9 to 520 RPM.

The StraitLine gearmotor combines all the best customer-preferred features proved through 25 years of manufacture for a major motor manufacturer.

Western Gear has designed its line of gearmotors utilizing the "building block" principle. This results in a minimum renewal parts inventory because of parts standardization, and in a high degree of interchangeability. Motor packages and gear sets are easily interchanged, and ratios changed simply and quickly, right in the field.

StraitLine gearmotors, both integral and all-motor, are available for immediate delivery in a wide variety of sizes and reductions, through Western Gear's district sales offices, representatives and distributors.

Glenn Malme • **Western Gear Corporation**
P. O. Box 182 • Lynwood, California EMJ

Please send me information on StraitLine Gearmotors.

name _____

title _____

company _____

address _____

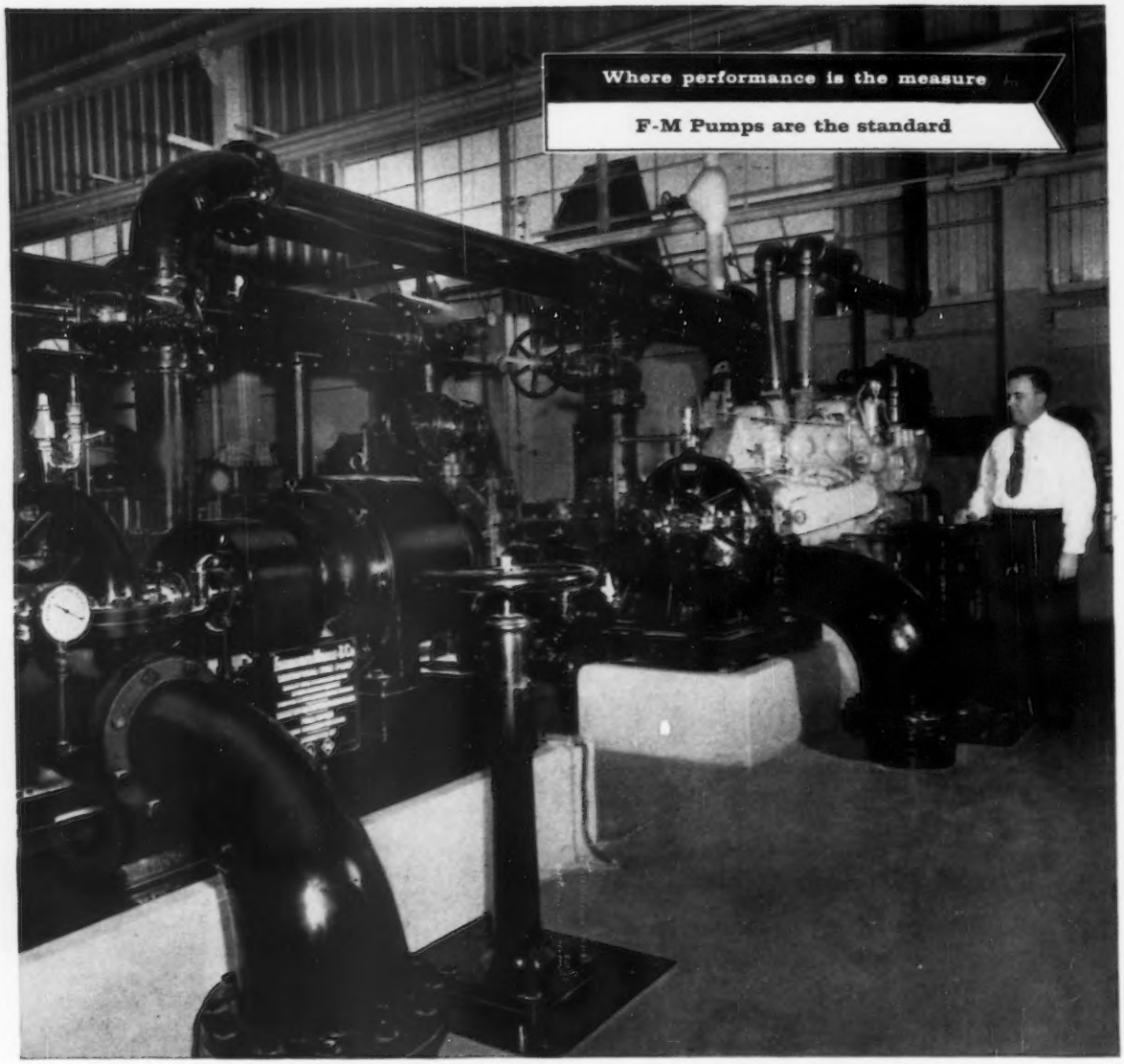
city _____ state _____

See your Western Gear Man in all principal cities about StraitLine gearmotors.

"The difference is reliability" • Since 1888

5603

WESTERN GEAR Corporation
ENGINEERS AND MANUFACTURERS



Mr. George Biggar, plant engineer of Ford Motor Company assembly plant at Mahwah, N. J., checks Fairbanks-Morse fire pumps (1500 gpm. motor-driven pump in foreground, 2500 gpm. diesel-driven pump near Mr. Biggar).

Ford guards against fire at giant new plant

To protect one of the world's largest auto assembly plants against fire, Ford Motor Company depends on these two Fairbanks-Morse fire pumps. As the heart of an extensive system, the two F-M pumps provide defense in depth, one pump backstopping the other.

This installation is typical of the great care and planning by modern industry to prevent the catastrophe of fire. Call in your F-M Sales Engineer for expert assistance in pump specification. As builder of the world's greatest variety of hydraulic combinations, Fairbanks-Morse will provide the exact type, exact size pump you need for maximum dependability.

For information write Fairbanks, Morse & Co., Dept. EMJ-4, 600 S. Michigan Ave., Chicago 5, Ill.

Ask for F-M Fire Pump Bulletins 5814F (horizontal) and 6920F (vertical).

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

PUMPS • SCALES • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MAGNETOS

CYANAMID

REAGENT NEWS

"ore-dressing ideas you can use"

600 Series AERO® Depressants --For Effective Gangue Control and Slime Depression

These time-tested reagents continue to be useful the world over as aids in the flotation of ores containing troublesome gangue slimes. The series includes AERO Depressants 610, 615, 620 and 633. Generally fed as 5% solutions, effective dosages range from 0.05 to 0.5 lb/ton of ore.

Listed below are some typical case histories outlining how the 600 Series AERO Depressants are being used to control or depress carbonaceous and talcose gangue slimes, improve selectivity and concentrate grade, and cut consumption of other flotation reagents.

Flotation of gold-bearing sulfides – 0.4 lb/ton AERO Depressant 633 effectively depresses graphitic slime, improves concentrate grade and recovery and subsequent roasting-cyanidation operations.

Lead-zinc flotation – 0.03 lb/ton AERO Depressant 633 in lead circuit and 0.04 lb/ton in zinc circuit depress actinolite and improve concentrate grades without sacrificing recovery.

Graphite flotation – Up to 1.0 lb/ton AERO Depressant 633 slows down graphite flotation helping to prevent over-flocculation and mechanical entrapment of gangue.

Pyrite flotation – Use of 0.072 lb/ton AERO Depressant 620 keeps down talcose slimes at gold-uranium operation. Required pyrite concentrate grade not attainable without AERO Depressant 620.

Copper-zinc-gold – Combination of AERO Depressants 615 and 620 at approximately 0.4 to 0.5 lb/ton, together with SO_2 solution (about 0.2 lb/ton S), depresses talc and chlorite gangue in copper circuit. Zinc is floated from copper tailings without addition of 615 or 620. Zinc tailings are leached with AERO® Brand Cyanide for gold recovery.

Lead-zinc flotation – AERO Depressant 610 at 0.05 lb/ton improves selectivity of zinc float by depressing gangue, loosening froth and improving concentrate grade.

A Cyanamid field engineer will be glad to discuss the possible application of these products in your flotation operation.

AMERICAN CYANAMID COMPANY
MINING CHEMICALS DEPARTMENT
30 ROCKEFELLER PLAZA, NEW YORK 20, N.Y.

NORTH AMERICAN CYANAMID LIMITED
160 Bloor Street East,
Toronto 1, Ontario, Canada

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Apartado Postal 285
Mexico 1, D.F., Mexico

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Bush House, Aldwych, London W. C. 2, England

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CYANAMID AUSTRALIA PTY. LTD.
"Collins Gate"
277 Little Collins Street
Melbourne, Australia

Cable Address—Limenitro, New York

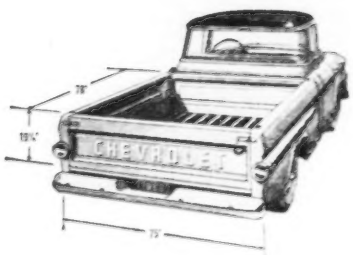
Just out! The newest in pickups!

NEW FLEETSIDE BY CHEVROLET

Here's the new sweetheart of the Task-Force fleet, Chevrolet's new Fleetside pickup! No truck has ever been better to look at . . . or better for your business.

Long, sweeping lines, graceful body contours . . . *new* truck appearance that's fleet, dashing and completely modern! Yet there's even more to the new Chevrolet Fleetside than the striking beauty that first meets your eye. There's *size*, for instance: extra room inside to pack many additional cubic feet of payload. And with double-walled lower side panels, durable hardwood floor, and solidly constructed full-width tailgate, the new Fleetside is the toughest of pickup bodies, too! A new adjustable latch keeps graintight tailgate free from rattles.

Here's a new high in hard-working utility, matched by new styling that makes you stand out on any street. See the new Fleetside at your Chevrolet dealer's now! . . . Chevrolet Division of General Motors, Detroit 2, Michigan.



More load space than any other comparable low-priced pickup. In lengths of either 78 inches or 98* inches and a full six feet in width, this new body actually provides 50% more cubic capacity than the conventional pickup box! **Optional at extra cost.*

Plenty of work-whipping hustle and muscle. Your choice of two great engines—standard 145-h.p. Thriftmaster 6 or optional at extra cost 160-h.p. Trademaster V8. And truck-engineered chassis components will take all the abuse your most bruising hauls can give them!

CHEVROLET **CHEVROLET TASK·FORCE TRUCKS**

WHAT BUT A BELT CONVEYOR could carry this load for so few pennies a ton?

Moving at high speed—24 hours a day if required—belt conveyors handle huge tonnages in a continuous stream. Loading and unloading delays are eliminated, and there's no time lost on empty return runs. Operating costs are relatively low, based on cost per ton handled. In fact, economies of belt conveyor operation and upkeep generally top any other form of bulk material transportation. And thanks to their extreme flexibility, installation is easy even in difficult locations.

WHO BUT LINK-BELT offers such a complete belt conveyor service? For any requirement—new installation or modernization job—Link-Belt will plan it, equip it, erect it and stand behind it. Our engineers can choose from industry's most comprehensive idler line—plus a broad range of pulleys, drives, terminal machinery and auxiliary equipment. Because all drawings and equipment come from one source, responsibility is centralized . . . no need to waste valuable engineering man-hours coordinating drawings from several sources.

OVERALL ENGINEERING | COMPLETE EQUIPMENT | SKILLED ERECTION | ASSURED SATISFACTORY PERFORMANCE

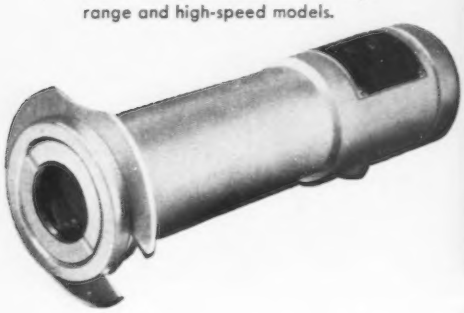
Add to the basic economies of belt conveyors the extra advantages offered by Link-Belt—it's a formula producing lower costs per ton for all industry. Your nearby Link-Belt office can furnish complete information. 14,621

LINK-BELT

BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs.

General Purpose *Radiamatic* Unit — for applications in the temperature range from 200 to 4000 F. Available in low, intermediate and high-range and high-speed models.



Small Target *Radiamatic* Unit — for temperature range from 1700 to 7000 F. Available in five models, depending on size of target and temperature requirements.

Miniature *Radiamatic* Unit — for range from 200 to 3200 F. For use where space is limited and small targets must be observed at short distances.

Measure "problem" temperatures with a *Radiamatic* temperature detector

USE *Radiamatic* detectors to measure the temperature of moving objects without physical contact . . . or for representative temperatures over large areas . . . or where abrasion, vibration, shock or corrosive atmospheres exist. *Radiamatic* temperature detectors are used extensively in pelletizing, in reduction and beneficiation of low grade ores—where thermocouples can't be used.

These detectors operate faster than thermocouples. You can easily interchange various types of *Radiamatic* units in your installation to meet changing requirements. They're reliable, maintenance-free production aids that give long service in any application. *Radiamatic* detectors have ambient temperature compensation to 350 F.

There's a complete line of *Radiamatic* accessories—sighting and target tubes, mounting frames, supports, air and water cooled fittings —where necessary—for varied installation needs. And there's a complete line of Honeywell indicators, recorders and controllers for use with these units.

Get complete details from your nearby Honeywell field engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

First in Controls

The Tractors That Industry Drafted...

The NEW JOHN DEERE "440's"

The highly mobile new "440" Wheel Tractor is ideal for construction and maintenance work of all types.

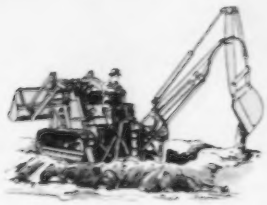
Ruggedness, power, operator's comfort, and all-around economy are featured in the new "440" Crawler.

A new, complete line of John Deere quality-built working equipment matches the "440's" to the construction job.

THE new John Deere Crawler and Wheel Tractors are just what industry ordered—big-capacity power at low cost—low in initial cost and in operating cost.

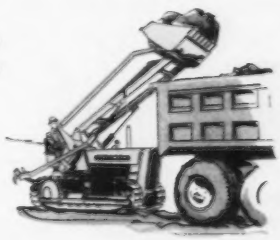
Both John Deere Tractors are ruggedly built from grille to drawbar . . . designed, inside and out, to fill definite needs in industrial work of all types . . . to cut costs to rock bottom on every job you assign them. Both tractors are built around the amazingly efficient John Deere engine, unmatched for delivering so much for so long for so little. Both are ruggedly constructed and boast many features, including optional clutch-type direction reverser, that enable them to do more than their share of the day's work. Power steering on wheel type is available if desired.

Let your John Deere industrial dealer fill you in on the many qualities of design and construction that make these tractors so suitable for the rough, tough everyday jobs of modern industry.



Deep-digging, highly efficient backhoes . . . power-operated trenching units . . . and fast working scrapers are available for both crawler and wheel models.

Inside- and outside-mounted, hydraulically controlled bulldozers team up with the high-torque John Deere Crawler to handle a wide variety of work.



Heavy-duty front-end loaders with rear-end scarifiers make fast work of earth moving. Exclusive clutch-type direction reverser saves time, effort on many jobs.

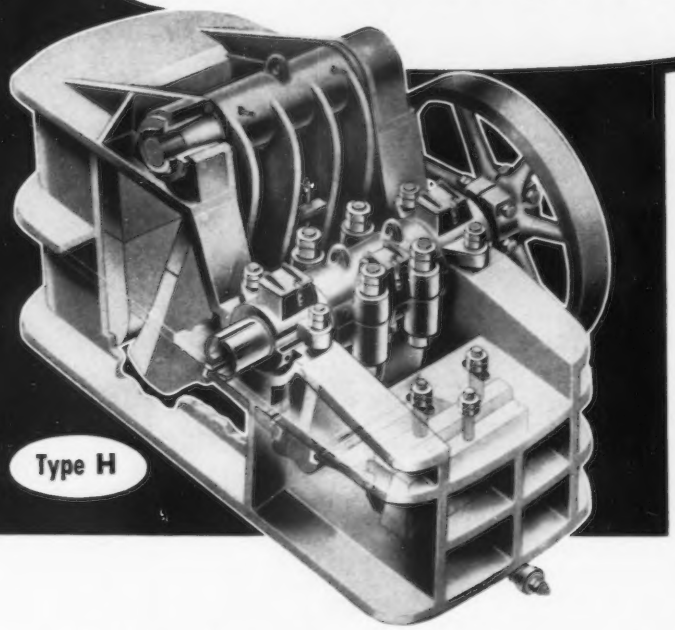
Your John Deere industrial dealer can tell you of the many other types of equipment available for use with John Deere Industrial Tractors.

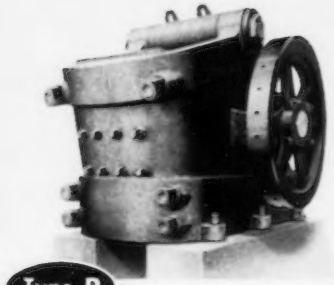
JOHN DEERE Industrial Tractors and Equipment

Completely Engineered for Industry

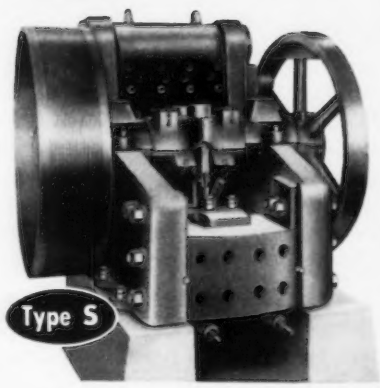
For Further Information Write: **JOHN DEERE INDUSTRIAL DIVISION • MOLINE, ILLINOIS**

Traylor-MADE
JAW CRUSHERS
for the mining industry





Four types of the hundreds of Traylor Jaw Crushers used throughout the world — with over half a century of engineering experience and know-how built into each. Features include non-chokable smooth-faced curved jaw plates, which allow for greater capacity at fine setting and longer life of wearing plates. Frames are reinforced at critical points to provide strength without excessive weight. Write for bulletins: Type H, 6105; Type HB, 104; Type R, 1123; Type S, 125.

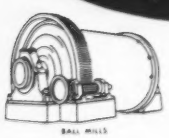


Traylor

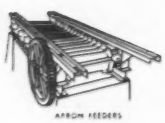
TRAYLOR ENGINEERING & MFG. CO., 1031 MILL ST., ALLENTOWN, PA.

Sales Offices: New York — Chicago — San Francisco

Canadian Mfr.: Canadian Vickers, Ltd., Montreal, P.Q.


BALL MILLS

ROTARY KILNS


APRON FEEDERS

PRIMARY GYRATORY CRUSHERS

JAW CRUSHERS

SECONDARY GYRATORY CRUSHERS

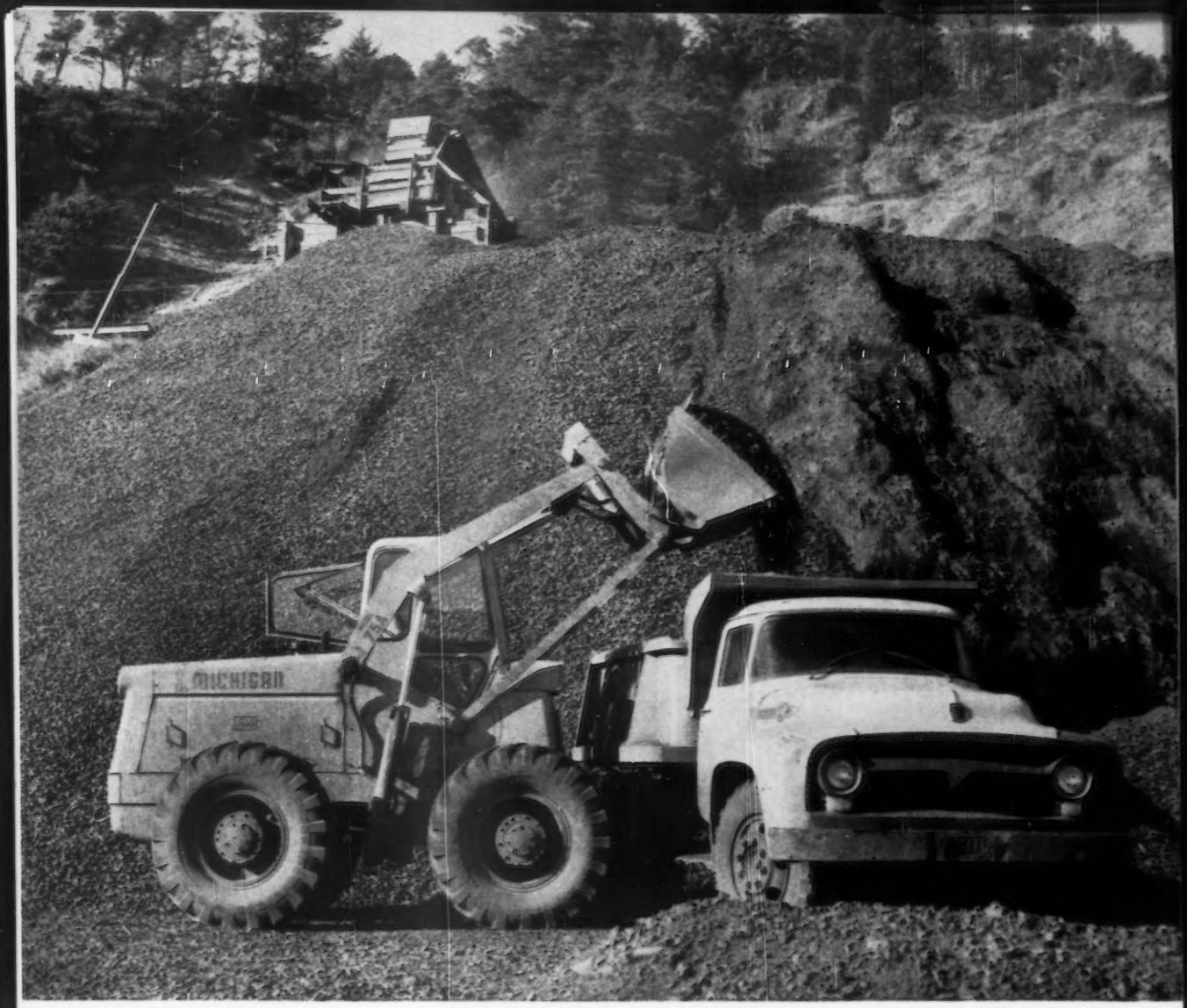
Harbison-Walker Refractories withstand Explorer's terrific blast-off heat!

The pad from which earth satellite Explorer was launched by the Army is paved with Harbison-Walker Extra Strength Castable Refractory.

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
General Offices: Pittsburgh 22, Pa.

The high refractoriness and great strength of Harbison-Walker Extra Strength Castable, which enable it to withstand blast-off temperatures and shock, make it particularly adapted for its wide industrial use.

Launching Pad paved with Harbison-Walker Castable Refractory



In 3 years, 1¼ yd Michigan loads 300,000 yds of rock. Yet...

REPAIR COSTS TOTAL $18.45

In studying most efficiency reports, you have to remember one extremely important fact: that the data given usually cannot legitimately be applied to machines now available. Changes galore—for good or bad—have been made since the veteran unit was built. That is why this report seems to us so significant. The Michigan Tractor Shovel described is in every important component ***EXACTLY*** *like the Michigans made today. In fact, all 8,000 Michigan Tractor Shovels built have been like the first one—a tribute to the efficiency of design and efficiency of their all-Clark designed and built power trains.*

For the past three years, Yaquina Head Quarries, Newport, Oregon, has used this Model 75A Michigan Tractor Shovel 6 to 8 hours a day, 5 days a week, truck-loading crushed rock. The machine has handled over 300,000 yards of material, ranging in size from ¼" to 4" minus.

Its only downtime in all these months has been for changing points and plugs, and for replacing two emergency brake cables.

The work took less than 30 minutes and parts cost exactly $18.45.

For this superb record, credit belongs partially to excellent machine design and construction . . . partially to Plant Supt Virgil Landess' insistence on a simple, regular, preventive maintenance program. The Michigan is greased every day. Rear end and torque converter are checked twice a week. Oil is changed every 40 hours, filters every 80 hours, and a one-hour maintenance check made every two weeks.

"Cheap insurance for keeping an excellent machine excellent," says Quarry Owner Roy Sawyer.

Stock-piles at the Yaquina Head quarry are located in a quarter-mile semi-circle around the crusher, on two levels. Good brakes, excellent visibility, 26 mph speed, fingertip power steering combine to cut travel time between loading locations.

Material—after shooting, secondary shooting, crushing, and normal 2½-to-1 swell—weighs 2600 to 2800 lbs per yd. Mostly basalt, tests show a very small percentage of iron in the rock. Assays have picked up gold, too—80c worth per ton.

Steep 20% grade between stockpile levels proves no problem for the powerful four-wheel-drive Michigan—even in wet weather.

Among the many odd jobs done by Yaquina Head's quarries mobile Michigan Tractor Shovel: moving a 4,000 lb crusher head.

Loads typical truck in one minute

The 80 hp Michigan speeds all kinds of scattered assignments. It lifts crusher heads, for example. Picks timbers. Sets motors. But mostly it loads trucks. "Everything from pickups to 15 yard semis with 8 ft high sides," describes Owner Sawyer. A typical 5 yard truck is loaded in four bucket-fulls. Time: 1 to 1½ minutes.

Reduces truck waiting time 80%

Fast loading—plus fast travel between the nine stone stockpiles—has cut truck waiting time to practically zero. "In the old days—when we handled loading with a ¾ yard rubber-tired machine of another make—trucks often had to wait 10 to 15 minutes each for loading service," remembers Mr. Sawyer. "That old machine couldn't load out more than 250 yards a day. Our Michigan easily loads 400 to 500 yards a day. And it *has* loaded as much as 835 yards (in 8 hours)."

Eight models now available

How do your production requirements compare? If they're the same (or less), your most economical bet for the job probably would be a Michigan 1¼ yard all-wheel-drive model (like the machine described here). For greater output, you have a wide choice of bigger machines: with 2, 2¾, *and the new 4 or 6 yard buckets* (standard SAE measure). For clean-up around crushers and belts, there's a 16 cubic *foot* size. Eight standard models in all. See your Michigan Distributor for details.

CLARK EQUIPMENT COMPANY
Construction Machinery Division
2465 Pipestone Road
Benton Harbor 7, Michigan
In Canada: Canadian Clark, Ltd.
St. Thomas, Ontario

Michigan is a registered trade-mark of

CLARK® EQUIPMENT

Now! The greatest concentration built into a truck engine!

Ford's all-new Super Duty V-8's—with displacements of 401, 477 and 534 cubic inches—are designed to handle GVW's up to 51,000 lb. and GCW's up to 75,000 lb. on America's toughest runs. And their endurance has been proved, not only in dynamometer labs and on the proving grounds, but in commercial fleets from coast to coast.

You get more miles with less downtime! These all-truck engines combine an entirely new concept of engine cooling with the latest developments in mechanical design and materials, setting new Ford standards of performance and dependability in heavy-duty truck service. Here is the "how and why" of Ford's superiority:

Exclusive three-stage cooling provides fast, uniform warm-up. Coolant flow is controlled by a second thermostat that balances the rate of warm-up and expansion of block and heads. Stress concentrations and the possibility of head warpage are virtually eliminated.

High-capacity water pump, the heart of Ford's cooling system, circulates over 200 gallons per minute. High volume coolant flow, with little or no aeration, supplies vital scrubbing action at valve guides and seats. Another advantage of this unique pump—its high capacity (50% more than competitive types) is obtained with no increase in required horsepower.

Water-jacketed fuel-air intake passages, in manifold *and* heads, maintain correct and uniform fuel temperatures from carburetor to combustion chambers. This results in proper vaporization and equal distribution of fuel-air mixture to each cylinder for improved economy and maximum engine smoothness.

New "In Block" combustion chambers transfer heat concentration from heads to block for 360° chamber cooling. This transfer allows better cooling of head and valve areas, greatly increasing the life of these parts. Combustion heat absorbed by the head of the aluminum alloy piston is transferred to the long, solid piston skirt. From there it is readily dissipated through the cylinder wall into the coolant which surrounds cylinder throughout the entire length of piston travel. The result is long life pistons and rings.

Internally mounted oil cooler keeps oil at lower temperatures for better lubrication. Reduced oil temperatures maintain greater oil film strength and reduce oil carbonization. Also, cooler oil means cooler running, longer lasting rod, main and camshaft bearings.

Fully machined combustion chambers mean close tolerances for accurate regulation of compression pressures. In Ford's new Super Duty V-8's, all surfaces of the combustion chamber (cylinder wall, bottom of head and top of piston) are precision-machined. Piston tops have a tapered step to maximize turbulence for improved combustion with regular grade gasoline. The smooth, straight surfaces of this wedge-shaped combustion chamber eliminate deposit-forming pockets to minimize harmful preignition.

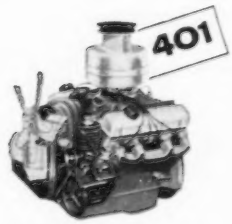
Turbulence Top pistons have four rings and three of them, including the oil ring, are chrome-faced for long life. The top ring groove has a bonded cast-iron insert to further reduce wear. Piston tops are extra thick to withstand high compression pressures. Each piston contains thermal struts that control expansion for a precise fit, hot or cold.

Hard-faced intake *and* exhaust valves with wear-resistant valve seat inserts are a Ford exclusive. Valves are made of heat-resistant materials and heads are dish-shaped to allow them to seat readily. To minimize the possibility of sticking, valve stems are electrolized, a surface treatment previously restricted to aircraft engines. Positive rotators provide a self-cleaning action for

NOW!
Three all-new all-truck V-8's

277-hp Short Stroke V-8 . . .
Torque: 490 lbs-ft @ 1800-2300 rpm

260-hp Short Stroke V-8 . . .
Torque: 430 lbs-ft @ 1800-2300 rpm



226-hp Short Stroke V-8 . . .
Torque: 350 lbs-ft @ 1800-2300 rpm

American Business buys more Ford Trucks than any other make!

# of endurance features ever

They're all standard in Ford's new Super Duty V-8's

more perfect seating and sealing. Any valve material requires good cooling for long life. Ford's new Super Duty engine design makes more coolant available for lower valve temperatures. This coolant flowing past Ford's integral valve guides quickly carries away valve heat. In addition, exhaust valves are sodium-filled for rapid transfer of heat from head to stem. The sodium is added by a unique process that eliminates welding, thereby strengthening the valves.

Hot testing of every Super Duty V-8 is a typical example of Ford's quality control. Each engine is run for 20 minutes to check smoothness, timing, valve lash adjustment, oil pressure, and push rod rotation.

The engine is then partially disassembled. Parts are inspected for condition and alignment. Special attention is given to bearings and other items that might cause premature failure. The engine is then reassembled and run for about 10 minutes to check timing, noise level, acceleration, smoothness and coolant, oil or compression leaks. Only Ford uses such a detailed inspection of every engine. This is done to provide you with a more dependable truck.

New submerged electric fuel pump virtually eliminates vapor lock and maintenance problems. Mounted in the bottom of the tank, it pushes solid fuel under pressure from tank to carburetor. Its electric motor is sealed in a stainless steel capsule, and operates the pump by magnetic drive.

Every engine part is a truck engine part designed and built exclusively for Ford's all-new Extra Heavy Duty trucks. The same attention to detail required for durability in the major components has been carried over to all other parts as well. Listed below are but a few typical examples:

Stainless steel gaskets at heads and exhaust manifolds practically eliminate tie-ups due to blown gaskets.

No external oil lines to break. Oil filter and air compressor are mounted directly to block.

Valve stem seals are of same material developed for use in government missile program.

Rotor-type oil pump maintains high output, virtually unaffected by normal wear from extended operation.

Dual exhaust system provides far easier breathing and higher volumetric efficiency.

Alternator system replaces generator for longer electrical life.

Biggest Ford trucks ever built! Ten new series—Tilt Cabs, Conventionals, Tandems—up to 51,000-lb. GVW, 75,000-lb. GCW. For complete information see your local Authorized Ford Dealer.

Big truck built... big truck powered... at Ford's low prices!

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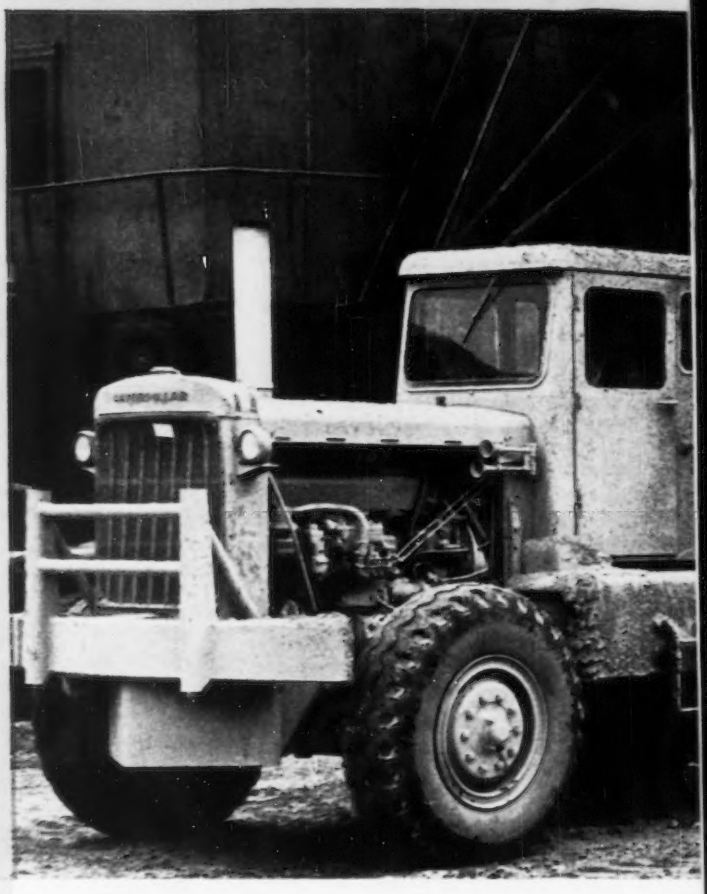
Hauls Material . . .

An *Athey* First.. "T-1" Steel in Bottom Dump Trailer Design



6 New DW20-PW20 Bottom Dumps

Utah Construction Company's fleet of 6 PW20 Bottom Dumps has been stripping overburden from the copper deposits at a large open-cut copper operation. The new Athey-Cat PW20-DW20 Bottom Dump Trailers were selected on the basis of their ability to produce. Utah reports, "The units are giving good performance. We like their low vehicle weight-to-load ratio."

The Athey PW20 is *all new*, with many design features for faster, lower cost hauling. Dead weight is trimmed to minimum by the use of high-strength "T-1" steel. The DW20-PW20 team handles 40-ton payloads – nearly 4 times the trailer weight.

Three doors – instead of *two* – dump the load. When the two extra-wide bottom doors open, the rear door swings back – ends "hang up" on the dump.

Not Dead Weight!

strip overburden at one of America's largest copper mines

This is another exclusive feature which keeps material flowing on the dumping operation.

Power plant for the PW20 is the Cat DW20 Tractor. It is world-proved for dependability, low maintenance, profitable day-in, day-out performance.

COMPARE THESE FEATURES:

"T-1" Steel Construction – PW20 40-ton payload capacity is nearly 4 times trailer weight. No excess weight means lower operating costs, less maintenance.

High Rear Clearance Design – Up to 5 ft. clearance permits the unit to ride out over – not through – the dumped load.

3-Door Dumping – Load empties through wide bottom doors *and* rear door. Material dumps instantly, or can be windrowed under positive hydraulic-actuated control.

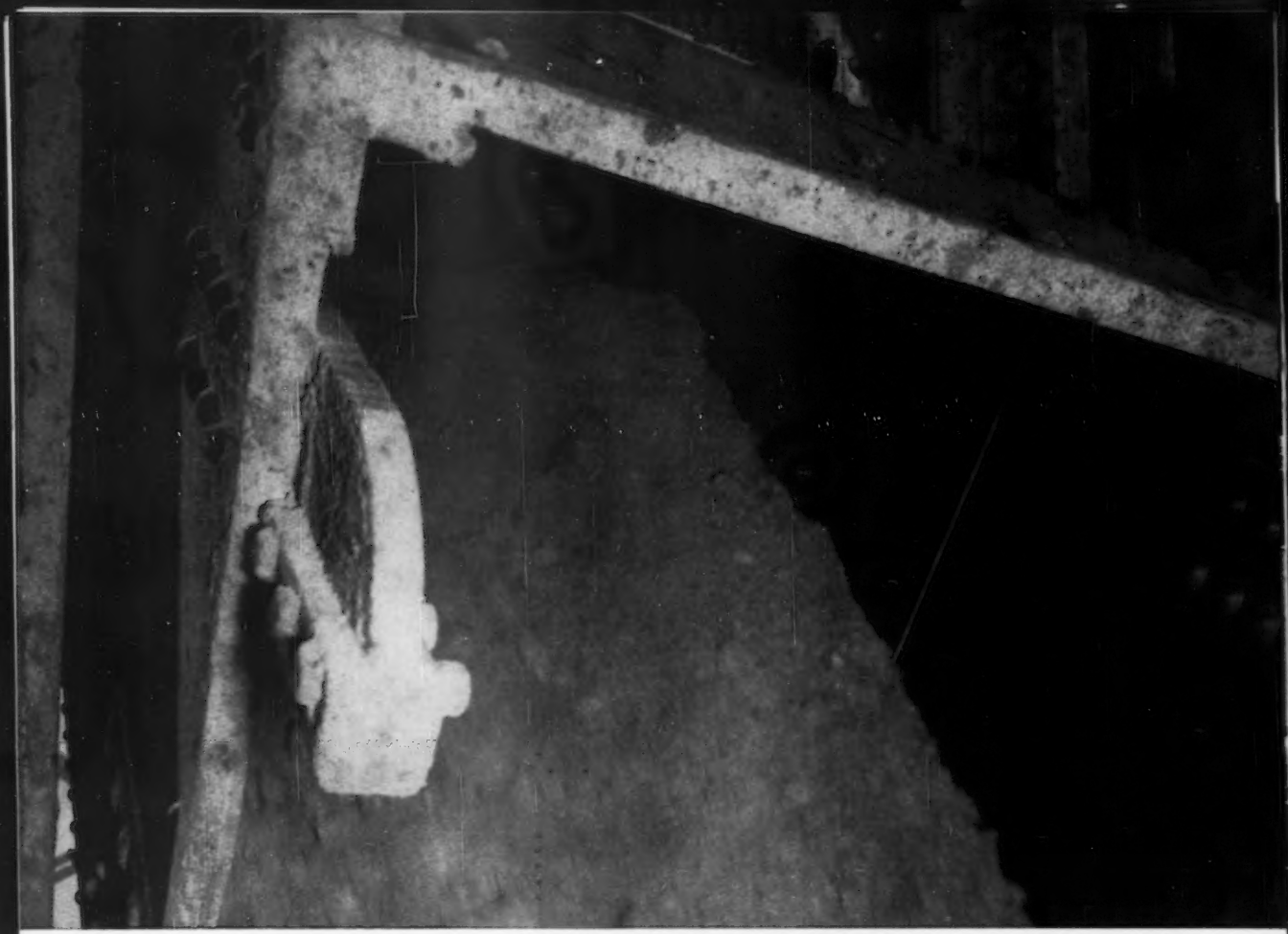
Low Loading Height – An average height of only 8′ 9½″ cuts down shovel loading time, gives you more yards per hour, more loads per day.

Steep Side Slope – 18° side plate angles help speed dumping, give less "funneling" action to material.

Why take less than the best? You, too, can get maximum production and efficiency on your hauls. See your Athey-Caterpillar Dealer for complete details. Have him show you the new movie of the PW20 in action. Athey Products Corporation, 5631 West 65th Street, Chicago 38, Ill.

Athey

THE COMPLETE TRACTOR-TRAILER LINE... *BY THE LEADERS*



Skip bucket liners of USS "T-1" Steel cut dead weight, last longer, cost less to replace than the liners previously used.

"T-1" Steel doubles the life of skip bucket liners

—reduces weight by ½ ton

Skip hoist at Miami Copper Company Mine, Miami, Arizona, hauls abrasive copper ore up a 1080-foot shaft, making 80 trips per hour.

This skip hoist at the Miami Copper Company Mine, Miami, Arizona, has two skip buckets which weighed 19,350 pounds each. The old liners, made of structural carbon steel, consisted of 1-inch-thick bars riveted to ⅜-inch-thick plates. By replacing this arrangement with ½-inch-thick plates of USS "T-1" Steel, weight was reduced by almost half a ton.

The present USS "T-1" Steel front dumping-lip liner and the side liners last more than twice as long as the previous liners. What's more, fabrication costs for a complete lining have been reduced by more than 90%, and replacement time cut to a fraction.

What USS "T-1" Steel can do for you. This versatile steel has a combination of properties unexcelled for mining equipment. It has nearly 3 times the yield strength of structural carbon steel, outstanding resistance to impact abrasion, exceptional toughness, even at temperatures as low as −50°F., and is readily weldable without preheating.

This means you can get rid of dead weight and lower your costs by using USS "T-1" Steel for dippers, sticks, booms, chutes, hoppers, cars, and other equipment. Write for our booklet, "Mining's Metal, USS 'T-1' Steel." United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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Now for air legs! a removable bit that's one-piece strong!

Here is a removable bit for air-leg drills that has the strength of one-piece steels. It's the new Timken® tapered socket bit. The tapered union gives you all the advantages of removability and a strong secure union for use with air-legs.

Because the new Timken tapered bit is removable, you get all these advantages that intraset steels can't provide:

You don't have to throw away the drill steel just because the carbides wear out. You do with intrasets.

You carry a few bits down into the mine instead of a load of steel. You can't with intrasets.

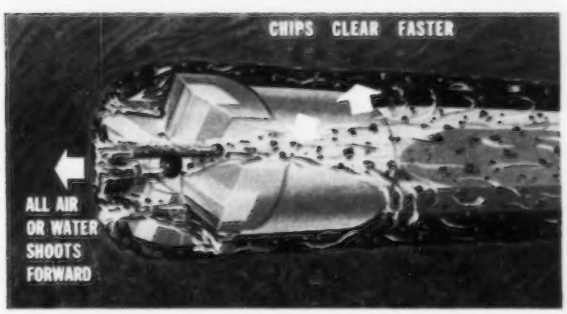
You can quickly change bit gauge sizes using the same steel. You can't do this with intrasets.

You don't have to lug the whole steel back just to resharpen the cutting edges. You do with intrasets.

You get four carbide cutting edges. You get only two with chisel intrasets.

And the new frontal design of the Timken tapered bit gives you faster chip clearance because 1) new five front holes shoot water or air directly against the rock face and 2) new deeper, wider wing clearance lets chips wash back faster. New special-analysis carbide inserts give superior wear-resistance with added shock-resistance, can be reconditioned many times.

For removability *and* strength, use the air-leg bit of the future. Write for our free brochure. The Timken Roller Bearing Company, Rock Bit Division, Canton 6, Ohio. Cable: "TIMROSCO".



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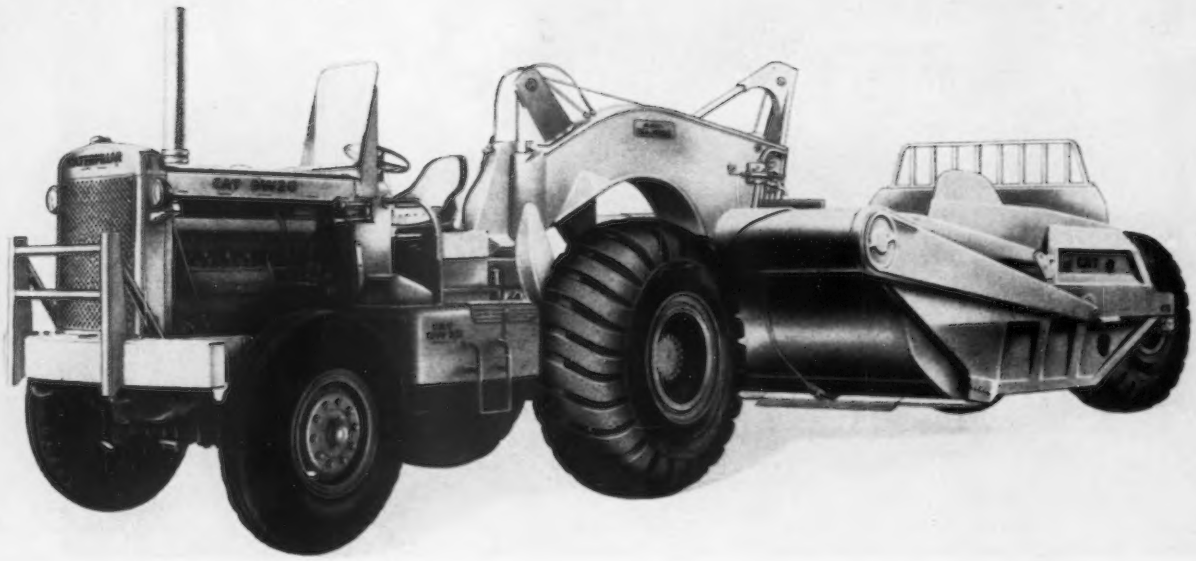
THE AIR-LEG BIT OF THE FUTURE

HERE THEY ARE!

DW20 and DW21 WITH



DW20
(SERIES F)

New HP—320 (maximum output)!
New Torque—28% torque rise!
New Speeds—up to 35.8 MPH!

Powered with a brand-new SUPER-TURBO Engine, these big Caterpillar rigs are faster, more powerful than ever. Horsepower of both the DW20 and DW21 is increased to 320. At equal rimpulls, speeds are 10% greater, and torque rise is more than double compared to the previous models. Now you can move earth faster and easier—and still have the dependability for which Cat equipment is famous.

Behind the new performance of the new DW20 (Series F) and DW21 (Series D) is their new SUPER-TURBO Engine. This amazing power plant incorporates a new concept in diesel engine turbocharging. Its heart is a revolutionary air induction system, unique in earthmoving machines . . . and another Caterpillar first.

This system allows use of more of the Turbocharger's potential than was possible before. Results: twice as much torque rise, higher horsepower, better acceleration and gradeability.

But more important, these results translate into faster cycles, greater production and more profit—*for you.*

NEW INCREASED HORSEPOWER

DW21
(SERIES D)

New HP—320 (maximum output)!
New Torque—28% torque rise!
New Speeds—up to 22.6 MPH!

Add to these DW20 and DW21 power advantages all the design features of Caterpillar LOWBOWL Scrapers. These matched units are built to use the greatest possible loading potential of the new power in the tractors.

Higher horsepower! New torque rise! Faster working speeds! Your production will hit new highs and your costs will drop when you turn these improved rigs loose on your job.

Call your Caterpillar Dealer right now and set up a demonstration on a job of your choice. The sooner you see the powerful new DW20 and DW21 in action, the sooner you'll start getting bigger returns from *your* wheel spread.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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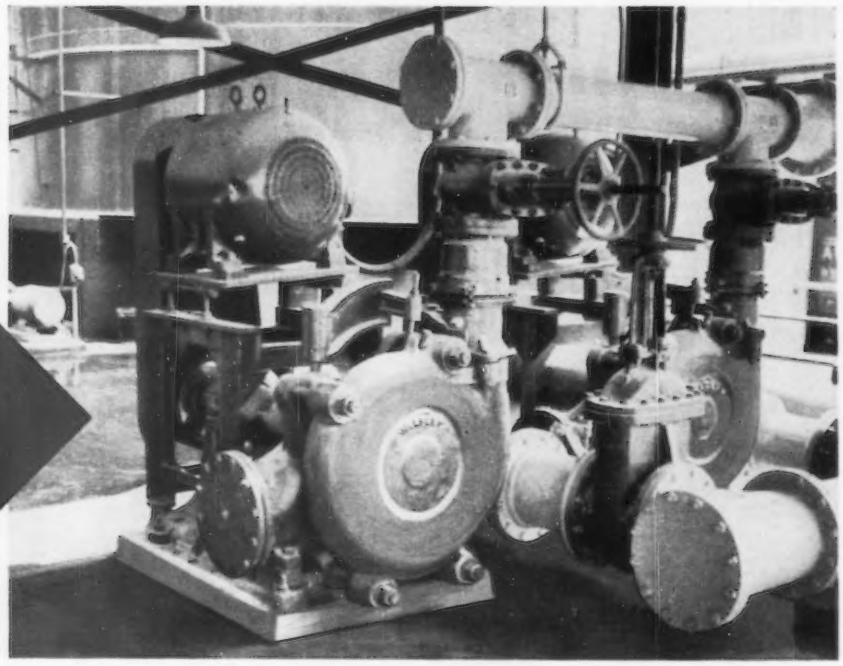

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Electrons and Ions . . .

$$Na^{\circ} - e = Na^{+} = \left[\text{atom} \right]^{+}$$

. . . Keys to Mineral Processing

JAMES W. FRANKLIN, Associate Editor

TWO FUNDAMENTAL CONCEPTS govern, and have always governed, metal and mineral processing every step of the way—electron transfer and ion exchange. The electrons, with their negative charge, whirling about in orbits around the positively-charged protons in the nucleus, are the source of all metallurgical reactions.

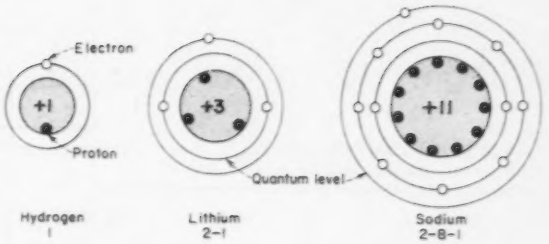
Leaching, purification, precipitation, reduction, roasting, fire refining and electrowinning all start with an electron transfer. So do the newer processes which go under the misleading names of ion exchange and solvent extraction.

Metals must be activated before they will ionize and react. Metals must be goaded into action by putting them into solution, heating them, contacting them with a reactive gas, or by putting them into the molten or fused state. What method the metallurgist chooses to use will depend on the kind of metals and minerals involved, their concentration, and on how much he can afford to spend on their recovery. Low-grade ores are usually leached—high-grade smelted.

Metals in their pure state contain an equal number of electrons and protons, and are electrically neutral. To enter into a reaction, a metal must become an ion. To become an ion, a metal must give up electrons. Some metals become ions readily; others not so readily, because each metal has its own peculiar electron structure. Metal reactions can be predicted by knowing the electron structure.

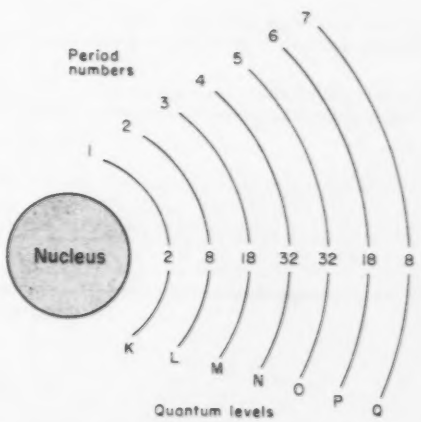
All the naturally occurring elements are listed in the Periodic Table on pp 86-87 which lists the metals and nonmetals in order of their increasing atomic weight and increasing number of electrons. Horizontal rows, called Periods, divide the table into seven rows according to the number of electron orbits (shells, periods or quantum levels) in the elements. Vertical rows, called Groups, divide the table according to the number of electrons in the outer quantum level of each element. There are only seven period numbers because there are no more than seven quantum levels in any element. There are eight group classifications because there can only be eight outer electrons at the most in any element.

Hydrogen, the lightest element, consists of one proton and one electron. It appears at the upper left in Group Ia. Helium, the next heaviest, is an inert gas and has two protons and two electrons, and two new particles called neutrons. All the elements above hydrogen are made up of protons and neutrons in the nucleus, and electrons in the quantum levels outside. Only the electron is involved in metallurgical reactions; neutrons only serve to increase the atomic weight of the elements.



As an element increases its atomic weight, it also increases the number of electrons surrounding the nucleus, and eventually the number of quantum levels to a maximum of seven. Hydrogen, in the drawing above, is less active than lithium which is less active than sodium, because the electron structure in each case is different. Figures under the drawings indicate the number of electrons in each quantum level of the element shown.

Period Levels Determine Activity



Maximum number of quantum levels possible is seven, as shown on the drawing. Period numbers and corresponding quantum level alphabetic designation are shown. Drawing also shows the maximum number of electrons permitted in a quantum level, provided there is another quantum level further to the outside.

Arranging the Naturally Occurring Elements in Groups and Clues to

Group numbers from Ia through VIIb show the number of electrons in the outer quantum level of an element. Going from left to right across a Period, metal activity decreases within the Period because the number of electrons in the outer quantum level is increasing

Positive valence of metals is the same as the Group number for metals in Group Ia and IIb. Valence of the other metals in the other Groups is variable. This number is also the oxidation number of the element in that Group

This is the chemical symbol of the element and is used to make chemical equations

Period numbers show the total number of quantum levels in a metallic element. The more quantum levels in a metal atom, within a given Group, the more active that metal will be because the outer electrons are further away from the positive charge of the nucleus and they are screened by more intervening quantum levels

Atomic number of an element is the top number in each box

Atomic weight of each element is the lower number in each box

The alkali metals occur in group Ia

The alkali earth metals are in Group IIa

	Ia	IIa	IIIa	IVa	Va	VIa	VIIa	VIII
	+1	+2	← Oxidation numbers indicate the be donated or accepted in an					
1	1 H 1.008	← Salt, oxide and base formers →						
2	3 Li 6.94	4 Be 9.013	← Reducing agents → ← All these are metals →					
3	11 Na 22.99	12 Mg 24.32	← Transition metals give, take or share electrons →					
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.95	24 Cr 52.01	25 Mn 54.94	26 Fe 55.85
5	37 Rb 85.48	38 Sr 87.63	39 Y 88.92	40 Zr 91.22	41 Cb 92.91	42 Mo 95.95	43 Tc 99	44 Ru 101.1
6	55 Cs 132.91	56 Ba 137.36	57 58 La to 138.92 71	72 Hf 178.6	73 Ta 180.95	74 W 183.9	75 Re 186.3	76 Os 190.2
7	87 Fr	88 Ra 226.05	89 90 Ac to 227 103					

6	Lanthanide series	58 Ce 140.13	59 Pr 140.9	60 Nd 144.3	61 Pm 145	62 Sm 150.4	63 Eu 152
7	Actinide series	90 Th 232.05	91 Pa 231	92 U 238.1	93 Np 237	94 Pu 242	95 Am 243

Periods According to Increasing Atomic Weight Offers Many Metallurgical Reactions

Group numbers from VIIb through Ia show the number of electrons in the outer quantum level of an element. Moving from right to left across a Period, nonmetallic characteristics decrease within the Period because the number of electrons in the outer quantum level is decreasing

VIII		Ib	IIb	IIIb	IVb	Vb	VIb	VIIb	O	
number of electrons that must oxidation-reduction reaction →				+3	−4 +4	−3 +5	−2 +6	−1 +7	0	← Negative valence of Groups VIb and VIIb nonmetallics is the difference between the Group number and the figure eight (8) – the magic number of electrons in the outer quantum level of the inert gases in Group O. Oxidation number and its charge is as indicated in this row
→					← Acid, and salt reformers →				2 He 4	1
→					← Oxidizing agents →					
				5 B 10.82	6 C 12.01	7 N 14.01	8 O 16	9 F 19	10 Ne 20.18	2
→				13 Al 26.98	14 Si 28.06	15 P 30.98	16 S 32.07	17 Cl 35.46	18 A 39.94	3
27 Co 58.94	28 Ni 58.69	29 Cu 63.54	30 Zn 65.38	31 Ga 69.72	32 Ge 72.6	33 As 74.91	34 Se 78.96	35 Br 79.92	36 Kr 83.8	4
45 Rh 102.9	46 Pd 106.7	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3	5
77 Ir 192.2	78 Pt 195.2	79 Au 197	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209	84 Po 210	85 At 210	86 Rn 222	6

Period numbers show the total number of quantum levels in a nonmetallic element. The more quantum levels in a nonmetallic atom within a Group, the less active that nonmetallic will be because the outer electrons are further away from the positively charged nucleus

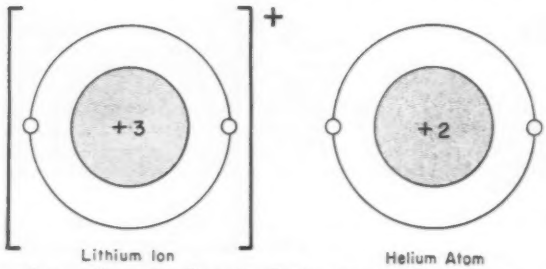
The inert gases are in this column

These are the halogen elements

Adopted for this purpose from J.A. Timm's *General Chemistry*, McGraw-Hill Book Co. (1956)

64 Gd 156.9	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.2	69 Tm 168.9	70 Yb 173	71 Lu 175			6
96 Cm 245	97 Bk 245	98 Cf 248	99 E	100 Fm	101 Mv	102	103			7

Elements Give or Take Electrons



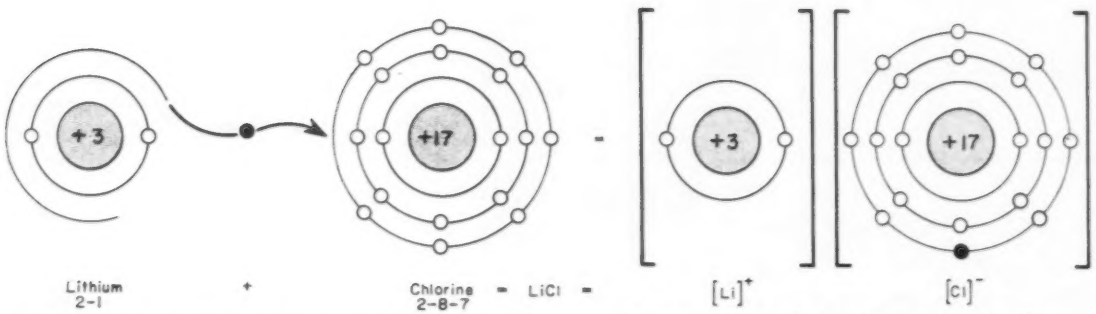
Group O on the Periodic Table contains the inert gases which set the pattern on how an element within a Period will react. Because they have their outer quantum levels satisfied as to maximum permissible electron totals. Helium has only two electrons in its outer K level—the maximum number permissible in any K level. All the other inert gases have eight outer electrons—the maximum number permissible in any outer quantum level. Elements give up, take or share electrons so that their outer electron number equals that of the inert gases, and in doing so become ions, react with other elements to gain a measure of stability.

Helium ends Period 1 and starts Period 2. Any Period 2 metal in Groups Ia and IIa can ionize, react and gain stability by giving up the outer electron to resemble helium's outer structure.

Transition metals (those in the center of the table) give, take or share electrons to resemble the inert gas nearest in their Period.

Nonmetals in Groups VIb and VIIb take up electrons to become stable for the same reason.

Metals Give Up Electrons To Become Ions



When the lithium atom gives up an outer electron, it becomes an ion with a single positive charge (because the number of electrons is now less than the number of protons) and resembles inert helium as shown above. Elements that give up electrons assume a positive charge, and are called metals. All metals are electron donors and replace hydrogen in an acid to form salts:

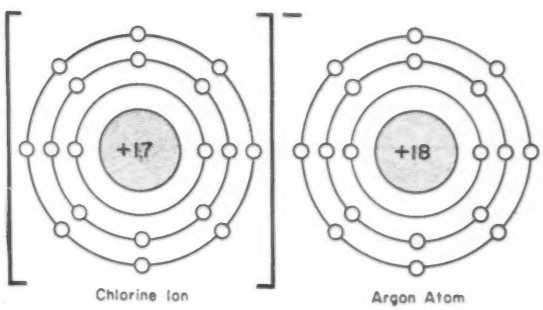
$$[Cu^{++}] + [2H^{+} + SO_4^{-}] \rightarrow [Cu^{++} + SO_4^{-}] + 2H^{+}$$

Metals combine with oxygen to form oxides:

$$2Fe^{+++} + 3O^{-} \rightarrow Fe_2O_3$$

Metals combine with sulphur to form sulphides and sulphates. They also form phosphates, carbides, silicides, halides, hydroxides and hydrides.

Nonmetals Take Up Electrons To Ionize



Chlorine, as shown at left, becomes an ion by accepting an electron from another element (usually a metal) to form a stable compound. Chlorine ion, by gaining an eighth electron in its outer quantum level, resembles the inert gas, argon. Nonmetals gain stability and ionize by accepting electrons so as to resemble the nearest inert gas within a Period. Nonmetals combine with metals to form salts:

$$Li^{+} + Cl^{-} \rightarrow LiCl$$

Nonmetals combine with hydrogen to form acids:

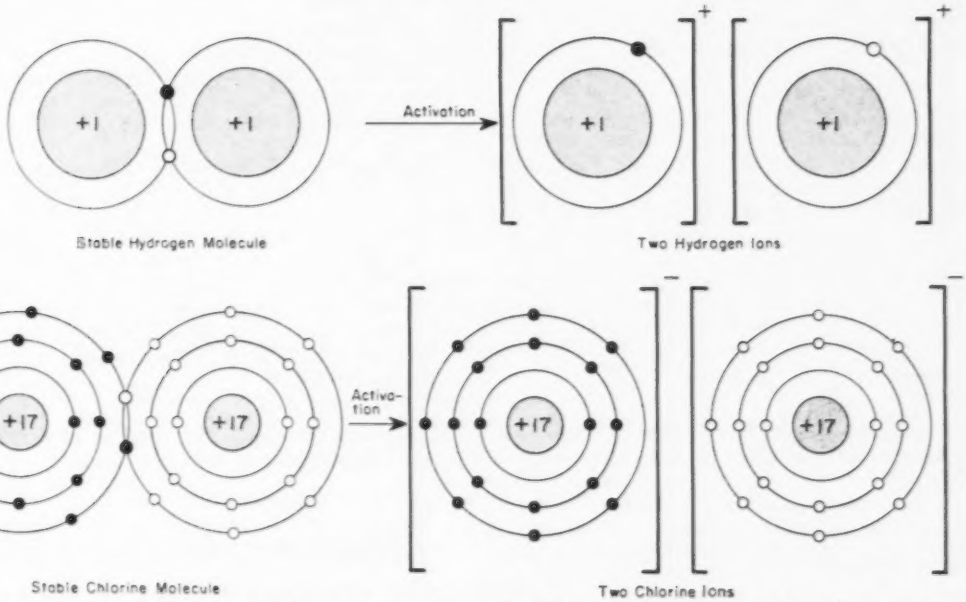
$$H^{+} + Cl^{-} \rightarrow HCl$$

And in the case of the active nonmetallic gases, they react with themselves to gain stability by sharing electrons.

Sharing Electrons Provides Stability

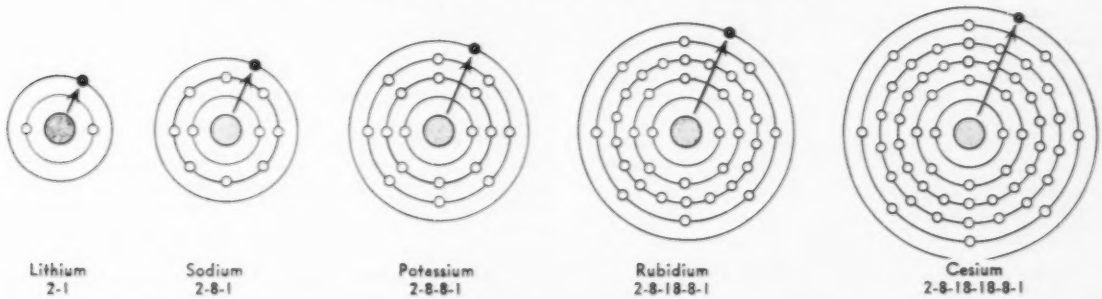
Halogens (F_2, Cl_2, Br_2 and I_2), nitrogen (N_2), oxygen (O_2), hydrogen (H_2), some of the acids (HCl, H_2SO_4) and most organic compounds exist as stable compounds by sharing electrons. The shared electrons may be provided by both participants as shown, or by one of the ions furnishing all (or most) of the needed electrons. Shared electrons are called covalent bonds.

Compounds which exist through covalent bonding may or may not be soluble in water-like compounds. If the compound is of such nature that one of the ionic partners



attracts the shared electrons more strongly than the other, pulling the electrons closer to its nucleus, then the compound will be polar (resembling a small electromagnet) and will be soluble in water.

Metal Activity Increases Down a Period



Metals of like outer electron number are listed down the Groups on the Periodic Table in order of their increasing number of quantum levels. Each of the metals in the drawing above are from Group Ia and has one outer electron; yet there is a great deal of difference in their activity, because each metal in turn down the Group has more quantum levels and more shielding electrons placed between the positively-charged nucleus and the electron.

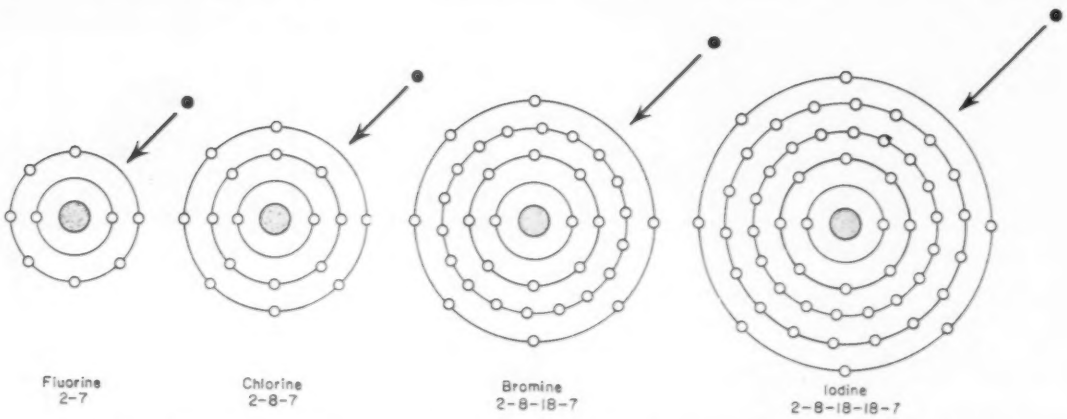
The more shielding electrons and the further away from the nucleus an electron is, the more reactive the metal will be, since the electron can easily be pulled away. Increasing length of the arrows on the drawing shows the increasing ease in which the outer electron can be removed. Cesium is the most reactive of the naturally occurring metals. Within any other group on the table, metal activity and metal characteristics increase down a Group.

Nonmetal Activity Decreases Down a Group

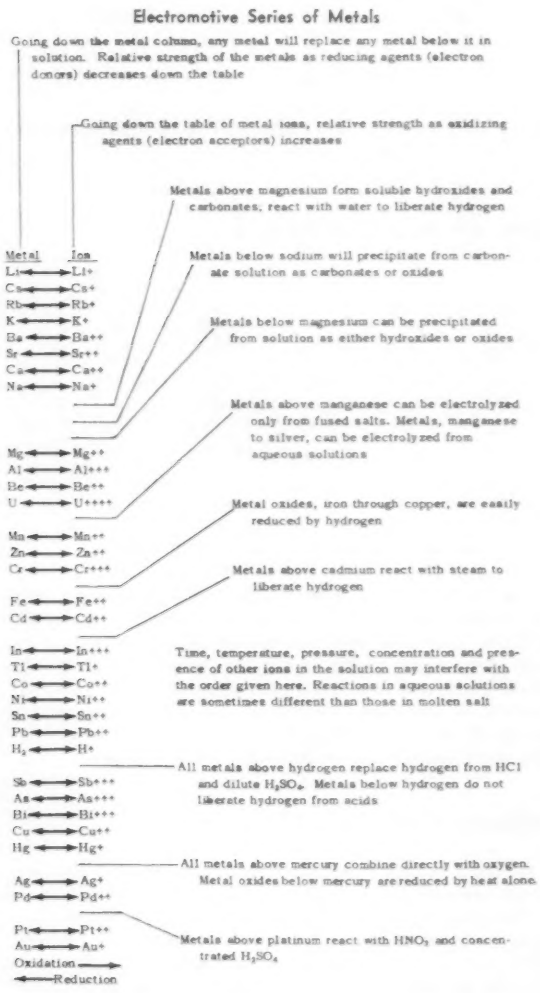
As is indicated by the increasing length of the arrows on the next page, the more quantum levels in a nonmetal, the harder it is to push an eighth electron into the outer orbit. In this case, instead of shielding, the inner electrons exert a repulsion force on the incoming electrons. Fluorine, the smallest nonmetal, is the most reactive element and cannot exist free in nature. Large, clustered, iodine is the most inactive nonmetal in Group VIIb. Nonmetal activity and characteristics decrease down a Group.

One further example of how the electron structure affects activity—please note Group IVb where one nonmetal is followed by four metals. Metal characteristics and activities increase down a Group, regardless of the Group.

Two other points on how electron structure affects reactions are important: (1) Transition metals show a variable valence and oxidation number which may or may not agree with the number of outer electrons. Transition metals have two unfilled outer electron shells. In a reaction, transition metals draw electrons from both levels to gain stability, and react easily with organic compounds such as ion exchanger resins, ion exchanger liquid and chelation agents. An example would be copper, which has only one outer



electron, yet always enters into a reaction with a valence or oxidation number of two. (2) Rare earth metals also exhibit this strange activity, having three outer electron levels from which to draw electrons.


Electromotive Series of Metals
Going down the metal column, any metal will replace any metal below it in solution. Relative strength of the metals as reducing agents (electron donors) decreases down the table
Going down the table of metal ions, relative strength as oxidizing agents (electron acceptors) increases
Metals above magnesium form soluble hydroxides and carbonates, react with water to liberate hydrogen
Metals below sodium will precipitate from carbonate solution as carbonates or oxides
Metals below magnesium can be precipitated from solution as either hydroxides or oxides
Metals above manganese can be electrolyzed only from fused salts. Metals, manganese to silver, can be electrolyzed from aqueous solutions
Metal oxides, iron through copper, are easily reduced by hydrogen
Metals above cadmium react with steam to liberate hydrogen
Time, temperature, pressure, concentration and presence of other ions in the solution may interfere with the order given here. Reactions in aqueous solutions are sometimes different than those in molten salt
All metals above hydrogen replace hydrogen from HCl and dilute H_2SO_4. Metals below hydrogen do not liberate hydrogen from acids
All metals above mercury combine directly with oxygen. Metal oxides below mercury are reduced by heat alone
Metals above platinum react with HNO_3 and concentrated H_2SO_4
Metal Ion
Li ⟷ Li+
Cs ⟷ Cs+
Rb ⟷ Rb+
K ⟷ K+
Ba ⟷ Ba++
Sr ⟷ Sr++
Ca ⟷ Ca++
Na ⟷ Na+
Mg ⟷ Mg++
Al ⟷ Al+++
Be ⟷ Be++
U ⟷ U++++
Mn ⟷ Mn++
Zn ⟷ Zn++
Cr ⟷ Cr+++
Fe ⟷ Fe++
Cd ⟷ Cd++
In ⟷ In+++
Tl ⟷ Tl+
Co ⟷ Co++
Ni ⟷ Ni++
Sn ⟷ Sn++
Pb ⟷ Pb++
H_2 ⟷ H+
Sb ⟷ Sb+++
As ⟷ As+++
Bi ⟷ Bi+++
Cu ⟷ Cu++
Hg ⟷ Hg+
Ag ⟷ Ag+
Pd ⟷ Pd++
Pt ⟷ Pt++
Au ⟷ Au+
Oxidation ⟶
⟵ Reduction

Metals form salts with acids. Here are some general rules of solubility – nitrates, chlorides (except AgCl, $PbCl_2$, Hg_2Cl_2 and sulphates (except $BaSO_4$, hot $PbSO_4$ and those of Ca, Hg and Ag) are soluble in water. All salts of sodium and potassium are soluble. Carbonates (except sodium and potassium), and sulphides (except sodium, potassium, calcium, barium and magnesium) are insoluble in water. Generally, the higher the temperature, the more soluble a compound will be.

Reactions, Rates and Results Can Be Predicted

METALS AND THEIR IONS have been investigated thoroughly in pursuit of the knowledge gained from the Periodic Table. Many of their reactions are summed up in the Electromotive Series as shown at left. But this table is not exact in every detail, as the electromotive series of metals alters slightly depending on the environment. Aqueous solutions produce a slightly different order in the series than do molten salt solutions. Temperature and the presence of other ions may also interfere.

Major importance of the table is in the fact that any metal will replace any metal below it in a reaction. Most of the processes used in mineral processing involve the substitution of one ion for another. By knowing the mineralogy and metallurgy of an ore, the metallurgist can predict what will happen in any reaction. The electromotive series provides this information, based on the electron structure of the individual metals.

Reaction rates can be increased by raising the temperature of the solution which increases the speed at which the electrons and ions move about, increasing their chance for collision and reaction. As a general rule, reaction rates can be doubled with every 10 degree rise in temperature above the point where a reaction takes place.

Endothermic reactions need sufficient heat to start the reaction, and still more to keep it going; raising the temperature of an endothermic reaction always helps. But exothermic reactions need only enough heat to set off the chain reaction; and subsequent lowering of the temperature as much as possible aids exothermic reactions.

Particle size is important in a reaction. Fine particles leach, roast, melt, smelt and reduce quicker than larger ones, because smaller particles provide more surface area on which a reaction can take place. Putting the metals into solution, whether aqueous or molten state, is an ideal way to get the finest possible particle size—the ion.

Electronegativity, or the ability to attract a pair of electrons, is an important property of an ion when using

the organic ion exchangers. As a rule, the more electronegative (or the more like a nonmetal) and ion is, the easier it will react with organic covalent compounds. Electronegativity is strongest at the upper right hand side of the periodic table (fluorine) and lowest at the lower left hand.

Solubility, melting and freezing points are other functions of the electron.

Purpose of this article is to review old and new metal and mineral processing techniques to illustrate how electrons transfer and ions exchange—how they've always performed in the four basic reactions. These reactions are —combination (adding a nonmetal to a metal); decomposition (basic in electrolysis); displacement (usually resulting in reduction to metal); and double decomposition (precipitating metals from solution with sulphides, carbonates, etc.).

Processes used to bring about these four basic reactions are many and varied, but they all, even the newer resin and liquid ion exchange processes, depend on electron transfer and ion exchange. Some processes are quite complex, but the basic ion exchange is simple. Others are just as simple as their metallurgy indicates.

Also reviewed are those "blue sky" approaches under current development that seek new ways to control the reactions of the high-melting point or reactive metals now in demand in the nuclear age.

How Electromotive Sequence Refines Gold and Silver

TO ACTIVATE A METAL, the metal must be put into solution, dissolved into its ionic form. That solution may be aqueous, molten salt or a gas. How the metallurgist chooses to activate the metal or its naturally occurring compound form will depend on its concentration, form and on how much the metallurgist can afford to spend to recover it. A fine example of ion exchange in metallurgy can be found in the recovery, concentration and refining of gold and silver.

Gold and silver are soluble in an aqueous solution containing cyanide ions with which they react to dissolve:

$$4Au+8NaCN+O_2+2H_2O\longrightarrow 4NaAu(CN)_2+4NaOH$$

After filtering off the solids, the pregnant liquor is deaerated and powdered zinc metal added to precipitate the gold and silver. Why? Zinc is above gold and silver in the electromotive series of metals, is a good reducing agent, and reacts by ion exchange to form a soluble zinc cyanide complex. Gold and silver precipitate as metals, their most reduced form:

$$2NaAu(CN)_2+4NaCN+2H_2O+2Zn\rightarrow Na_2Zn(CN)_4+2NaOH+H_2+2Au^{\circ}\downarrow$$

Precipitate is filtered, fluxed and smelted to slag off excess zinc and any base metals between zinc and gold in the electromotive series, that may have precipitated with the gold-silver. Bullion produced must be parted (see below).

In the case of copper tank-house slimes, the leaching step is bypassed because the concentration is much higher. Slimes may be smelted with sodium carbonate, potassium nitrate and silica to produce a slag containing the base metals and a gold-silver bullion.

In the lead smelter, gold and silver are recovered by the Parkes Process—a true case of solvent extraction in that no ion exchange is involved. By true solvent extraction is meant the contacting of two immiscible liquids which will not react with each other. In this case, the two liquids are molten lead and molten zinc, and as the zinc has a greater solubility for gold and silver than does lead, any gold-silver present will be dissolved in the zinc, purifying the lead.

Lead bullion, containing gold and silver, is placed in a kettle and molten zinc added. As the solution is allowed to cool, all the gold and silver, being more soluble in zinc than in lead, migrate into the layer of zinc that floats on top of the kettle. The pot is skimmed and the residue distilled to remove the zinc:

$$Au+Ag+Zn+Pb\rightarrow Au+Ag+Pb+Zn\uparrow$$

If the remaining bullion is heated with oxygen in a charcoal cupel, lead is oxidized and removed by skimming, or by absorption into the walls of the charcoal cupel.

Dore metal (bullion containing 70% Ag) can be parted in two ways—ion exchange with HNO_3, or electron transfer and ion migration by electrolysis. Silver dissolves in HNO_3 to form soluble silver nitrate:

$$Au+2Ag+2HNO_3\rightarrow 2AgNO_3+H_2\uparrow+Au$$

Solution is filtered, washed and a pure gold separated from the nitrate solution which can be electrolyzed to yield pure crystals of silver at the cathode:

$$Ag^{+}+e\rightarrow Ag^{\circ}\downarrow$$

Or the Dore metal may be used as an anode in a silver nitrate electrolyte. Under the influence of an electric current, silver gives up an electron:

$$Ag^{\circ}(\text{anode})-e\rightarrow Ag^{+}$$

and enters the solution, migrates to a pure silver cathode where it regains the missing electron and plates out as crystals of pure silver metal:

$$Ag^{+}+e\rightarrow Ag^{\circ}\downarrow(\text{cathode})$$

At the same time, gold drops down to form anode mud.

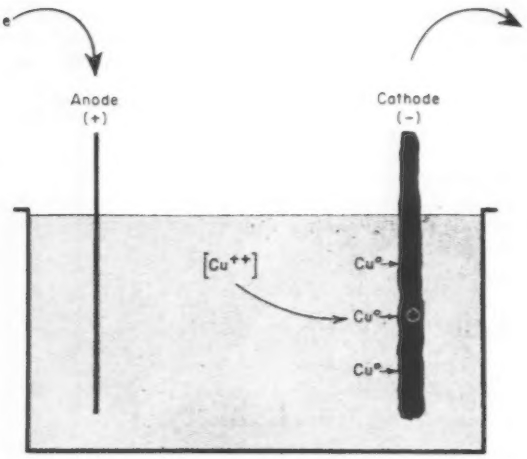
If the bullion is higher in gold than silver, it can be parted by electrolysis in a chlorauric acid electrolyte. This time, gold gives up electrons, goes into solution as an ion, migrates to the cathode where it regains electrons, and plates out as pure metallic gold. Silver dissolves into the electrolyte but immediately precipitates out as insoluble silver chloride.

Chlorine gas is used to part bullion on the Witwatersrand. Dry chlorine is bubbled through molten bullion, forming insoluble silver and base metal chlorides which are skimmed off the top. Gold is cast as 996 fine, and the silver residue partially reduced with soda ash, then brine leached to remove base metal chlorides. Silver chloride residue is reduced with scrap iron (iron being above silver in the electromotive series) to produce a silver concentrate that is cast into anodes for electrolysis.

So—to goad inactive gold and silver into action, the metallurgist has used every process at his disposal—leaching, displacement, reduction, precipitation, smelting and electrolysis.

(Continued on next page)

Using Ion Exchange in the Lead Smelter



SMELTING and refining of lead calls for all the electron and ion exchange methods available, plus use of true solvent extraction.

For blast furnace production, lead sulphide is roasted to remove the sulphur, then converted to a silicate which is an ideal lead blast furnace feed. The ion exchange of the roast can be expressed as follows:

$$2PbS+3O_2 \rightarrow 2PbO+SO_2$$
$$2SO_2+O_2 \rightarrow 2SO_3$$
$$PbO+SO_3 \rightarrow PbSO_4$$
$$2PbO+SiO_2 \rightarrow Pb_2SiO_4$$
$$2PbSO_4+SiO_2 \rightarrow Pb_2SiO_4+2SO_2\uparrow$$

During the roasting, FeS, Sb_2S_3 and ZnS are oxidized and the antimony volatilized as As_2O_3 gas. In the blast furnace, the remaining antimony is driven off in the gases, while iron and zinc enter the slag. Lead is reduced with carbon:

$$Pb_2SiO_4+CaO+FeO \rightarrow CaO\cdot FeO\cdot SiO_2+2PbO$$
$$2PbO+C \rightarrow CO_2\uparrow+\underline{2Pb^\circ}\downarrow$$

Lead must be softened with oxygen to remove Cu, As, Sb and Sn (all of which show a greater affinity for oxygen than does lead):

$$2Pb+4Cu+4As+4Sb+Sn+9O_2 \rightarrow 2Cu_2O \text{ (to dross)}$$
$$\rightarrow 2As_2O_3 \text{ (a gas)}$$
$$\rightarrow 2Sb_2O_3 \text{ (a gas)}$$
$$\rightarrow SnO_2 \text{ (litharge slag)}$$
$$\rightarrow 2PbO$$

Or the lead can be softened by adding PbO:

$$Pb+Zn+2Sb+5PbO \rightarrow 5Pb+PbO+ZnO\uparrow+Sb_2O_3\uparrow$$

Or the lead can be chlorinated to remove the zinc:

$$Pb+2Zn+Cl_2 \rightarrow Pb+ZnCl_2 \text{ (dross)}$$

Copper can be removed by adding sulphur—copper being more reactive than lead:

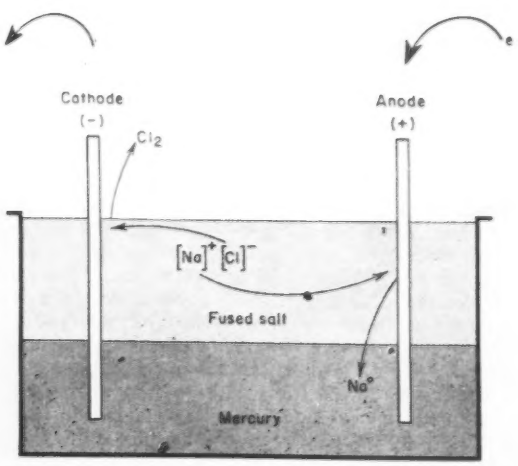
$$Pb+Cu+S_2 \rightarrow Pb+\underline{2CuS}\downarrow$$

To remove gold and silver, see Parkes Process under gold and silver.

High purity lead is produced by the electrolysis of lead anodes in either a fluosilicic or sulphamic acid bath. In the Betts Process, anode lead gives up electrons, enters the electrolyte as lead fluosilicate, migrates to the cathode where it regains electrons and becomes metal. Copper, silver, gold, bismuth and arsenic, if present, remain as anode mud. Zinc, iron, cobalt and nickel dissolve in the electrolyte and must be removed from time to time to prevent contamination.

Once again, the metallurgist has used every technique at his disposal to activate relatively stable lead so that it could be recovered and refined.

Electrolysis Is Electron Transfer and Ion Migration



ELECTROLYSIS INVOLVES THE FLOW of ions through an electrolyte which may be an aqueous solution or a molten salt.

If the process is being used as an electrowinning step, the dissolved metal ion is driven by the electric current to the cell cathode where it gains electrons and precipitates as a metal. If the process is being used to refine a metal, the metal serves as the anode.

Aqueous electrolysis is used to refine many metals—copper, lead, zinc, manganese, iron, gold, silver, chromium, gallium, indium, thallium, rhenium. Simple example is the electrowinning of copper from dilute sulphuric acid:

$$Cu^{++}+SO_4^{=}+2e \rightarrow SO_4^{=}+\underline{Cu^\circ}\downarrow$$

Electrorefining involves both electrodes of the cell:

$$Cu \text{ (anode)}-2e \rightarrow Cu^{++}$$
$$Cu^{++}+2e \rightarrow \underline{Cu^\circ}\downarrow \text{ (cathode)}$$

Fused or molten salts are also used to recover and refine those metals above aluminum in the electromotive series. All the active metals are produced by this technique:

$$2NaCl \rightarrow 2Na^+ + 2Cl^- + 2e \rightarrow \underline{2Na^\circ}\downarrow \text{ (cathode)} + Cl_2\uparrow$$

To prevent the sodium from reacting with the chlorine, a mercury or molten lead cathode is used. Sodium enters the mercury or lead and can be recovered as metal.

Fused salt is used to prepare misch metal from rare earth salts. It also is used to refine zirconium:

$$K_2ZrF_6+4NaCl+4e\rightarrow 2Cl_2\uparrow+2KF+4NaF+\underline{Zr^\circ\downarrow}$$

Primary aluminum is produced by a somewhat complex fused salt reaction, then refined to 4-nine quality (99.99% pure) by a similar fused salt reaction. Primary is produced in a Hall cell where the electrolyte is a fused salt of cryolite ($AlF_3 \cdot 3NaF$), alumina, and certain fluorides. Under the influence of the electric current, cryolite dissociates, producing aluminum which floats on top of the fused salt. Then the alumina in the fused salt reacts with the dissociated cryolite to produce more cryolite so that the process continues:

$$2(AlF_3 \cdot 3NaF)+6e\rightarrow 3F_2+6NaF+\underline{2Al^\circ}$$

$$Al_2O_3+3F_2+6NaF\rightarrow 2(AlF_3 \cdot 3NaF)+1\tfrac{1}{2}O_2$$

Refining is very similar. A cell is prepared with a molten aluminum-copper alloy anode covered by molten cryolite. Current drives aluminum from the anode into the molten electrolyte and out to gain electrons at the cathode, forming a layer of molten aluminum on top of the fused cryolite.

Ion exchange involved in the preparation of beryllium for electrorefining at Milford, England, was described as follows by P. S. Bryant in *IMM Paper No. 17 (1956)*—

Beryl crystals are roasted at 780 deg C with fluoride salt in presence of silicon tetrafluoride and soda ash to form soluble beryllium:

$$3BeO \cdot Al_2O_3 \cdot 6SiO_2+3NaSiF_6\rightarrow 3BeF_2+2AlF_3+6NaF+9SiO_2$$

Calcine is leached to produce a liquor from which beryllium hydroxide is precipitated with caustic and filtered:

$$BeF_2+2NaOH\rightarrow \underline{Be(OH)_2\downarrow}+2NaF$$

Hydroxide is redissolved in strong caustic and filtered from much of the metal hydroxides that came down with the Be. Steam heat decomposes the solution and reprecipitates $Be(OH)_2$ which is filtered, washed several times with ammonium chloride, then briquetted with coal and tar. Briquettes are chlorinated in towers to distill and collect beryllium chloride:

$$BeO+C+Cl_2\rightarrow CO\uparrow+BeCl_2\uparrow$$

Chloride is used in a fused salt cell with sodium chloride at 300 to 350 deg C, beryllium depositing at the cathode. Beryllium cathode is leached with caustic, then nitric acid, leaving behind pure beryllium metal.

Ion exchange techniques of leaching, precipitation, solution, reprecipitation, chlorination and fused salt are needed to produce the pure form of a very active metal.

How Bunker Hill Uses the Electromotive Series

BY KNOWING HOW an ion or a metal reacts in regard to the other ions in a solution, separations can be made that eliminate undesirable impurities from a process. An excellent example of the use of ion exchange is the Bunker Hill technique that removes magnesium and calcium from zinc concentrates prior to their use in production of electrolytic zinc.

Magnesium interferes with the electrolysis of zinc from zinc sulphate solutions because magnesium is above zinc in the electromotive series. Cathodes produced with much magnesium in the electrolyte show poor metal deposition and poor current efficiencies. Bunker Hill attacked the problem both in the mill and in the refinery.

They found that grinding concentrate to 91% minus 325 mesh reduced MgO and CaO content of the cleaner flotation concentrate by 33%. At the same time, percentage of zinc in the concentrate went up from 53.2 to 55.8% Zn.

Next step toward improved Special High production was the leaching system installed to treat 200 tpd of flotation concentrate. Concentrate is slurried in a ball mill at 50% solids, then leached at 40% solids with 10% solution of 66°Bé sulphuric acid. $MgCO_3$ and $CaCO_3$ react by ion exchange with the acid to produce insoluble $CaSO_4$ (gypsum) and soluble $MgSO_4$:

$$MgCO_3+CaCO_3+2H_2SO_4\rightarrow MgSO_4+2CO_2+H_2O+\underline{CaSO_4 \cdot 2H_2O\downarrow}$$

Leached pulp is agitated slowly to allow heavy zinc sulphide to settle out with the gypsum on top, then the liquor is decanted with a siphon and filtered. Concentrate is repulped several times to remove all the gypsum and soluble magnesium sulphate. Clean concentrate is filtered and sent to the roasting plant.

Roasting of a zinc concentrate takes place as the following ion exchange between zinc sulphide (solid) and oxygen (gas), a solid-gas ion exchange:

$$ZnS+PbS+3O_2\rightarrow ZnO+PbO+2SO_2\uparrow$$

Calcine is leached with dilute sulphuric acid to produce soluble zinc sulphate and insoluble (in hot solution) lead sulphate, which are separated by filtration:

$$PbO+ZnO+2H_2SO_4\rightarrow ZnSO_4+2H_2O+\underline{PbSO_4\downarrow}$$

In the electrolysis, the zinc ion migrates to the cathode and collects electrons to become metal:

$$Zn+2e\rightarrow \underline{Zn^\circ\downarrow}$$

With these techniques, Bunker Hill Co. is able to treat the high dolomitic lead-zinc ores now being found at the mines. About 21.8 tons of magnesia are leached out of the sulphides each month, leaving the electrolyte with only 15 gm/l of MgO (about half of former amount).—from W. Schmittroth, superintendent, Bunker Hill Co., Kellogg, Idaho, "Removal of Magnesia and Lime From Dolomitic Type Zinc Concentrate" presented at 1958 AIME annual meeting.

Using Zinc Metal To Precipitate Other Metals

PROPER USE of the electromotive series not only can purify solutions, but can convert an undesirable metal ion into a valuable commodity, for example—Anaconda Co.'s cadmium recovery process at Great Falls, Mont.

Electrolyte for the zinc cells contains soluble copper, lead, cadmium, cobalt and nickel ions which must be removed before the electrolysis can proceed. Simply adding powdered zinc metal will do the trick, since zinc is above all these metals in the electromotive series.

$$Impurities^- + Zn^- + Zn^\circ \rightarrow Zn^- + \underline{Impurities^\circ\downarrow}$$

Precipitate is filtered and sent to cadmium recovery, while the purified electrolyte goes on to the electrolytic zinc plant. In cadmium recovery, the residue, after being

allowed to oxidize to some extent, is dissolved in acidified spent electrolyte from both the electrolytic zinc and cadmium circuits. Solution is heated to 70 deg C to precipitate insoluble $PbSO_4$. Pulp is filtered, with cake going to Anaconda, Mont. for copper recovery and the pregnant liquor passing to the next step in the process.

Liquor is treated by the careful addition of more zinc to precipitate any residual copper:

$$Cu^{++}+Zn^{\circ}\rightarrow Zn^{++}+\underline{Cu^{\circ}\downarrow}$$

Copper is filtered and sent to Anaconda. Copper-free filtrate goes to another tank where more zinc metal is added to throw down cadmium:

$$Cd^{++}+Zn^{\circ}\rightarrow Zn^{++}+\underline{Cd^{\circ}\downarrow}$$

Sponge cadmium is collected on a disk filter and the filtrate passed onto the next tank. Here, the liquor is heated, and copper residue from above, arsenic trioxide and more zinc metal are added, precipitating all the cobalt, nickel and germanium. Cake is sent to Anaconda, while the purified liquor, which now contains only zinc ions, is sent to electrolytic zinc recovery.

Cadmium sponge from above is leached with sulphuric acid:

$$Cd+H_2SO_4\rightarrow CdSO_4+2H^+$$

Then it is heated to 70 deg C to remove traces of $PbSO_4$:

$$Pb^{++}+SO_4^{=}\rightarrow\underline{PbSO_4\downarrow}$$

Solution is filtered to remove the lead, then sent to the cadmium electrolytic cells. Anode is a lead-silver alloy and cathode is a sheet of aluminum. Electrolysis produces pure cadmium metal:

$$Cd^{++}+2e\rightarrow\underline{Cd^{\circ}\downarrow}$$

Cathodes from the cadmium cells must be melted for casting. This is done in a 15,000 lb capacity crucible where NaOH is placed on top to prevent oxidation of the cadmium. Metal is machine- or hand-cast at 750 to 900 deg F.—According to A. L. Alf, superintendent, Cadmium, Indium and Rare Metals Div., "Recovery and Production of Cadmium at Great Falls Plant of the Anaconda Co.", presented at the 1958 annual meeting of the AIME.

Ion Exchange in Ferrous Metallurgy

PROBABLY NO MODERN METALLURGICAL TECHNIQUE other than a complete copper or lead smelter is as complex as the ion exchange involved in ferrous metal production. J. L. Bray in his *Ferrous Production Metallurgy* shows twenty chemical equations covering the production of pig iron in a blast furnace. Few of the so-called (and misnamed) solvent extraction or ion exchange processes could compare with this for complexity.

Basic formula for pig iron is a reduction of iron oxides with carbon monoxide, coke and hydrogen:

$$3Fe_2O_3 + CO \longrightarrow 2Fe_3O_4 + CO_2\uparrow$$
$$Fe_3O_4 + CO \longrightarrow 3FeO + CO_2\uparrow$$
$$FeO + CO \longrightarrow Fe + CO_2\uparrow$$

Reaction of these three oxides with carbon is similar, except that CO is produced (rather than CO_2) and used in the upper part of the furnace to reduce oxides. Hydrogen reacts with FeO to produce iron and water:

$$FeO + H_2 \longrightarrow Fe + H_2O\uparrow$$

Pig iron can be refined by ion exchange with oxygen in acid- or basic-lined Bessemer converters. Acid-lined converters slag off S, Mn, and Si. Ferromanganese is added to throw down any FeO that may have been formed during the oxidation. But acid Bessemer cannot remove phosphorus, and it is necessary to use a basic-lined converter for phosphorus ores.

Open hearth metallurgy is generally the same as Bessemer, except the reaction rate is slower, and scrap iron and iron ore lump are used to provide the oxygen. To de-oxidize steel after removing the impurities, the metallurgist may add aluminum, which is above iron in the electromotive series and has a greater affinity for oxygen than does iron—this is the Killed Steel Process.

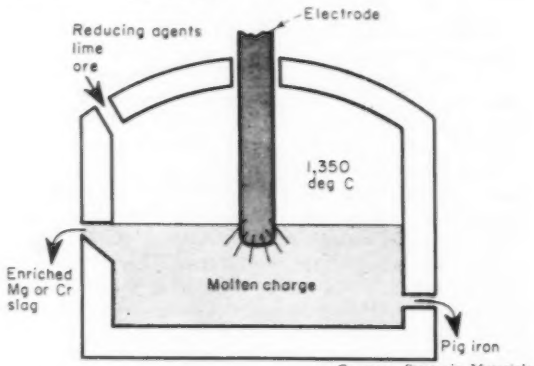
Electric furnace steel production also follows the same metallurgy as Bessemer, but phosphorus and sulphur cannot be removed to any great extent in an electric furnace.

For a broad coverage of direct reduction approaches to ferrous metallurgy, see *E&MJ* December 1957. Two processes not included in that survey deserve mention.

One is the Halverson Process which claims to remove titanium and phosphorus from iron ore by the addition of NaCl to the kiln. Ion exchange of the process is:

$$2NaCl + O \longrightarrow Na_2O + Cl_2$$
$$Na_2O + TiO_2 \longrightarrow Na_2TiO_3$$
$$CaO + Na_2TiO_3 \longrightarrow CaTiO_3 + Na_2O$$
$$Na_2O + CO + Cl_2 \longrightarrow 2NaCl + CO_2\uparrow$$

So far only small scale tests have been run by Tandem Mines Ltd., Toronto, but reports say that 10% titanium iron ores can be reduced and the slag processed for titanium recovery. Phosphorus and sulphur are removed in this basic slag process.



Courtesy Strategic Materials

The other is the Strategic Materials Process being promoted by Strategic-Udy Metallurgical & Chemical Processes, Ltd. (Sumac). Sumac has a $2-million prototype plant at Niagara Falls, Ontario, where double or triple smelting of iron ores, manganese ores or chromite is done.

Process reacts manganese ore with flux in first furnace at 1350 deg C to produce a high manganese (or chromium) slag and a low-phosphorus pig iron. Slag is tapped to second furnace where a trace amount of reducing agent (calcium carbide) is added to produce high-carbon ferromanganese (or chrome). If silicon is used as a reducing agent, ferromanganese silicon is produced and used in a third electric furnace to produce low-carbon or medium-carbon ferroalloy by the reduction of manganese slag from the first furnace.

Drawbacks—close temperature control is necessary to prevent volatilization of the manganese; very close electrode immersion control is required (only ½ to 2 in.). Is it economic? It is, and the Udys report that the power factor is 95%. Power consumption is reported at 3500 kwh per ton FeMn produced at 95% Mn recovery. Sumac is conducting research with Gunnar Uranium Mines Ltd. on chromite processing and has an operating agreement with Koppers Co., Pittsburgh, Pa. to conduct manganese research runs.

While the kiln and electric smelting processes just mentioned will remove impurities from the iron, direct reduction with hydrogen or CO-H_2 mixtures can only remove oxygen and a small amount of sulphur from the ore:

$$Fe_2O_3 + 3H_2 \longrightarrow 3H_2O\uparrow + 2Fe$$
$$Fe_3O_4 + 4H_2 \longrightarrow 4H_2O\uparrow + 3Fe$$

An interesting case of a catalyst being used to promote a reaction is the Esso Research-Arthur D. Little Process for direct reduction of iron ore with CO-H_2 mixture. Process takes advantage of the fact that powdered iron metal will crack methane (CH_4) to CO and H_2 at 1500 to 1600 deg F. Fine powdered iron from a previous batch run is added to the ore going into the reactor.

High Temperature Promotes Reactions

METAL OXIDES or halides can be reduced to metal by taking advantage of electromotive sequence in what are called bomb processes. Metal reducing agents react by ion exchange (substitution) with metal oxides or halides to liberate the other metals. Best-known bomb process is the Thermite or Goldschmidt Process which was developed to produce pure chromium by reduction substitution:

$$Cr_2O_3 + 2Al \longrightarrow Al_2O_3 + \underline{2Cr^\circ}\downarrow$$

Thermite reactions are highly exothermic, but if reaction temperature is not high enough to fuse the melting stock, a second reactive metal may be added to react with excess reducing agent generating the necessary heat of reaction.—Or peroxide can be used as is done in analytical chemistry.

Kroll Process for reactive metals is one in which the metal tetrachloride is reduced by substitution with sodium, calcium or magnesium. After the reaction is complete, the residual chlorides or fluorides can be leached away:

$$ZrCl_2 + 2Mg \longrightarrow 2MgCl_2 + \underline{Zr^\circ}\downarrow$$
$$ThF_4 + 2Ca \longrightarrow 2CaF_2 + \underline{Th^\circ}\downarrow$$
$$BeF_2 + Mg \longrightarrow MgF_2 + \underline{Be^\circ}\downarrow$$

Silicothermic reduction of magnesia with ferrosilicon will be used by Alabama Metallurgical to produce magnesium metal in a reaction that takes place at 1200 deg C, distilling pure magnesium away from the residue:

$$2MgO + 2CaO + SiFe \longrightarrow \underline{2Mg}\leftarrow + Ca_2SiO_4 + Fe$$

Reactive metals with high melting points can be produced by reduction with aluminum according to Lucio F. Mondolfo (U.S. Patent No. 2,803,536). Process is as follows: by reacting aluminum with reactive metal oxides at 2000 to 5000 deg C, an aluminum alloy is formed with the reactive metal which is separated from the ore.

Alloy is leached by alloying it with magnesium at up to 1000 deg C (inert atmosphere may be necessary) which forms a magnesium-aluminum alloy. Cooling the melt to 460 to 500 deg C causes the reactive metal to solidify into small particles within the molten magnesium-aluminum alloy.

Solid, pure reactive metal can be separated by decantation or centrifugation, and any residual magnesium leached with dilute acids. Patent says that any low-melting point metal can be used in the leaching step—zinc, tin, mercury or their alloys.

Complex Processes May Have Simple Metallurgy

PRECIPITATION OF METALS from aqueous solution with hydrogen is best illustrated by the Sherritt Gordon Process. Leaching, purification, selective precipitation, all play their part in the process; but hydrogen reduction at 350 deg F at 500 psi in the presence of a catalyst and nickel seed is the key.

Mixed Co-Ni-Cu-Fe sulphide concentrate is leached at Ft. Saskatchewan, Alberta, with compressed air and ammonia, the sulphides going into solution as ammoniacal sulphates. Iron precipitates from solution as Fe_2O_3.

Leaching may be represented as—at pH 1.5 to 2.5 and 250 deg F and 100 psi:

$$NiS + CoS + CuS + FeS + 8O_2 \longrightarrow NiSO_4 + CoSO_4 + CuSO_4 + FeSO_4$$
$$2FeSO_4 + 4NH_4OH + \tfrac{1}{2}O_2 \longrightarrow 2(NH_4)_2SO_4 + 2H_2O + \underline{Fe_2O_3}\downarrow$$

Copper is precipitated by hydrogen sulphide addition:

$$[Cu^{++}] + [SO_4^{=}] + H_2S \longrightarrow H_2SO_4 + \underline{CuS}\downarrow$$

Upon the addition of the ammonia, the cobalt and nickel were converted to the soluble diamine sulphate complex:

$$NiSO_4 + CoSO_4 + 4NH_4OH \rightarrow Ni(NH_2)_2SO_4 + Co(NH_2)_2SO_4 + 4H_2O$$

After the copper sulphide has been removed, the solution is stripped of most of the nickel and about 8% of the cobalt at 500 psi and 350 deg F with hydrogen:

$$Ni(NH_2)_2SO_4 + 2H^+ \longrightarrow (NH_4)_2SO_4 + \underline{Ni^\circ}\downarrow$$

All the remaining nickel, any iron present, and the cobalt are precipitated with hydrogen sulphide and sent to the cobalt recovery pilot plant:

$$NiSO_4 + CoSO_4 + FeSO_4 + 3H_2S \longrightarrow \underline{NiS}\downarrow + \underline{FeS}\downarrow + \underline{CoS}\downarrow + 3H_2SO_4$$

Sulphides are put back into solution with air and ammonia with the iron precipitating as Fe_2O_3 as above. Copper strip is omitted. Selective precipitation with hydrogen brings down all the remaining nickel and about 20% of the cobalt, then the remaining cobalt is precipitated with hydrogen, 500 psi, 350 deg F, and sodium cyanide and sodium sulphide catalysts:

$$Co(NH_2)_2SO_4 + 2H \longrightarrow (NH_4)_2SO_4 + \underline{Co^\circ}\downarrow$$

Full Sherritt Gordon flowsheet is shown in *E&MJ's* Mid-June 1957 Guidebook, while the process noted here is for the cobalt pilot plant as described by V. N. Machiw,

research director; W. C. Lin; R. L. Benoit; and T. B. Benz in "Nickel-Cobalt Separation at Sherritt Gordon Mines Limited" at the 1958 AIME annual meeting.

Cobalt and nickel can be recovered by chemical precipitation as is done at Nicaro, Cuba. Metals are dissolved in an ammonia-ammonium carbonate solution, filtered, stripped with steam and roasted to the oxide. Following equations are not balanced and only intended to show the ion exchange of the process:

$2NiO \cdot 2MgO \cdot 3SiO_2 + (Ni,Mg)O \cdot SiO_2 + 3(Ni,Mg) \cdot 2SiO_2 \cdot 2H_2O + H_2 + CO$—at 1350 deg F$\longrightarrow H_2O + CO_2$+reduced ore

Reduced ore$+1\frac{1}{2}O_2 + 6NH_3 + CO_2 \longrightarrow Ni(NH_3)_6 + CO_3$+ore

$2Ni(NH_3)_6 + CO_3 + 13H_2O$—at 220 deg F$\longrightarrow \underline{NiCO_3 \cdot Ni(OH)_2} + CO_2 + 12\ NH_4OH$

$NiCO_3 \cdot Ni(OH)_2$—2000 deg F$\longrightarrow CO_2\uparrow + H_2O\uparrow + \underline{2NiO_2}\downarrow$

$2NiO_2 + 1\frac{1}{2}O_2 + C$—1800 deg F$\longrightarrow NiO \cdot Ni\downarrow + CO_2\uparrow$

Another chemical leaching and precipitation process for cobalt and nickel is the Sill Process reportedly under pilot plant study at Newburgh, N. Y. Process is designed to recover metals from high-arsenic concentrates such as those produced at Cobalt, Ontario.

Flotation concentrate is leached with caustic and air at 250 deg F and 80 to 100 psi pressure, then filtered, leaving a metal residue and a filtrate containing all the arsenic and sulphur.

Arsenic is precipitated and recovered as calcium arsenate. Sulphur is recovered as Glauber salts.

Metal residue is dissolved in sulphuric acid, and filtered to leave behind a silver residue which is fire refined. Liquor is treated with lime to precipitate iron hydroxide which is filtered. NaOH and air are added to precipitate ferric hydroxide which is returned to the acid leach tank if it contains too much cobalt.

Filtrate from ferric ion removal stage is reacted with Na_2S to throw down copper as the CuS. Filtrate from this tank is contacted with chlorine and the cobalt precipitates. Cobalt is filtered and roasted to the oxide in a small Herreshoff roaster. Filtrate is fortified with soda ash or caustic to precipitate a mixed cobalt-nickel which is filtered back to the cobalt tank.

Nickel is stripped from the liquor with soda ash and roasted to nickel oxide. If the process is economic and all the end products can be sold, the Sill Process could be important to miners in the Cobalt camp, since it recovers all the silver and avoids the problem of arsenic fume.

Nickel sulphide can be processed by pyrometallurgy just as copper is. Outokumpu Oy plans to use flash smelting.

International Nickel Co. refines nickel and separates it from copper by the Carbonyl Process. Metal is reacted with carbon monoxide at 80 to 150 deg F, distilling out a nickel carbonyl, leaving the copper behind. Temperature is raised to 400 deg F and the carbonyl decomposes to nickel metal and carbon monoxide, which is returned to the process:

$$Cu + Ni + 4CO \longrightarrow Ni(CO)_4\uparrow + Cu$$
$$Ni(CO)_4 \longrightarrow 4CO\uparrow + \underline{Ni^\circ}\downarrow$$

Inco now uses electrolysis of nickel matte (anode) to produce high-grade metal—if the matte is low in copper. Process is installed at Port Colborne, Ont.

Still one other ion exchange process is in the works for the recovery and separation of nickel and cobalt. Solvent extraction processes have been suggested (see solvent extraction). One such process is reported to be so good that it is being kept under wraps until the patent is obtained. It may be used in a large nickel refinery soon.

Electromotive Sequence Governs Copper Production

IN THE RECOVERY, smelting and refining of copper, the metallurgist uses every technique mentioned so far, and in the forseeable future will add solvent extraction and ion exchange processes to this list. In the metallurgy of copper, heavy reliance is put on the reactions within the electromotive series of metals.

Copper minerals other than sulphides can be leached with a variety of acids, halogens and salt solutions. Recovery is most often affected by the addition of scrap iron or de-tinned cans to the pregnant liquor:

$$[Cu^{++}] + [SO_4^{=}] + Fe \rightarrow FeSO_4 + \underline{Cu^\circ}\downarrow$$

Or the copper can be precipitated with H_2S or Na_2S.:

$$[Cu^{++}] + [SO_4^{=}] + H_2S \rightarrow H_2SO_4 + \underline{CuS}\downarrow$$

Where scrap iron is not available, the copper is generally recovered by electrolysis:

$$Cu^{++} + 2e \rightarrow \underline{Cu^\circ}\downarrow$$

At Union Miniere du Haut Katanga, Jadotville, Belgian Congo, a FluoSolids reactor is used to sulphatize sulphide ore so that it can be leached in the regular malachite-oxide circuit. Reactions are as follows:

$$2Cu_2S + 5O_2 \rightarrow 2CuSO_4 + 2CuO$$
$$Co_2CuS_4 + 7O_2 \rightarrow 2CoSO_4 + CuSO_4 + SO_2\uparrow$$
$$4FeS_2 + 7O_2 \rightarrow 2Fe_2O_3 + 4SO_2\uparrow$$

Note that 80% of the sulphur remains in the calcine and is eventually recovered as sulphuric acid from the electrolytic cells.

Sulphide copper can also be smelted to matte in a blast furnace, but most of the copper recovered by pyrometallurgy is smelted in reverberatories, electric furnaces and flash smelters. The Russians have reported on pilot runs using a cyclone-type smelter, much like the unit being developed for the Cyclosteel Process.

For reverberatory use, the sulphides are roasted to remove most of the sulphur so that the reaction will go to completion in the matte. Flux (limestone in silica ore, silica on limestone) is added to the calcine going into the reverb. Slag from the converter step which follows the reverb is also added for two reasons—the smelterman can recover some of the copper that might be in the slag, and he needs a surplus of iron in the reverb to insure that all the copper goes into the matte.

Reverbs smelting calcine high in CaO and MgO report lower copper losses in the slag. This might be explained by the fact that calcium and magnesium appear above copper in the electromotive series and are better reducing agents. Their presence in the slag would tend to release copper to the matte.

Ion exchange in the molten mass within the reverb is:

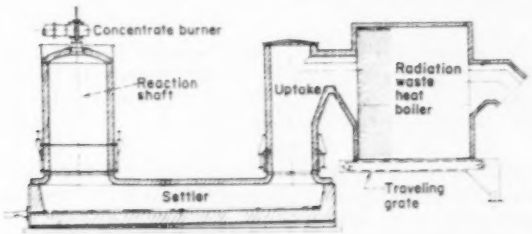
$$Cu_2S + 2CuO + 2FeS_2 \rightarrow 3Cu_2S + FeS + SO_2\uparrow$$
$$Cu_2O + FeS \rightarrow Cu_2S + FeO\ (\text{to slag})$$

A third equation is important at this stage of copper's metallurgy—the conversion of magnetite to the oxide in a reaction with pyrite at temperatures above 2200 deg F. preventing a build-up of magnetite within the reverb:

$$2FeS_2 + 5Fe_3O_4 \rightarrow 11FeO \text{ (to slag)} + 2SO_2\uparrow + FeS_2$$

In the reverb, iron being a better reducing agent than copper takes up oxygen; so does sulphur. Matte tapped from a reverb is high in copper and iron sulphides.

An electric furnace could be used to smelt sulphide ore to matte. Outokumpu Oy uses an electric furnace to clean up slag from the flash smelting operation.



From "Flash Smelting of Copper Concentrates," 1958 AIME

Roasting is omitted in flash smelting to produce matte because the ore is calcined in a solid-gas reaction as it is blown into the smelting chamber. Same metallurgical reactions take place in flash smelting as in the reverb, except that the reaction rate is quite high due to the fine particle size.

Three flash smelters are in operation—Inco at Copper Cliff, Furukawa at Ashio, Japan, and Outokumpu Oy, Finland. As shown in the drawing, gas and finely ground concentrate are blown into a combustion chamber where the sulphides smelt to matte and collect in the smelting settler where matte and slag separate. Reaction is exothermic so the heat is used to keep the mass molten and to provide steam for an electric generator set in the plant. Exit gases are cleaned in Cottrells to recover SO_2 for sulphuric acid production. Slag is tapped to an electric furnace for cleanup and matte to the converter.

In the Inco Process, finely ground pyrite is showered into the slag layer in the smelting chamber, the pyrite reacting to precipitate any copper held in the slag.

Matte from any of these processes is reduced in a converter by blowing air through the molten, highly-activated solution of metal and sulphur ions. Again the reaction proceeds according to the electromotive series:

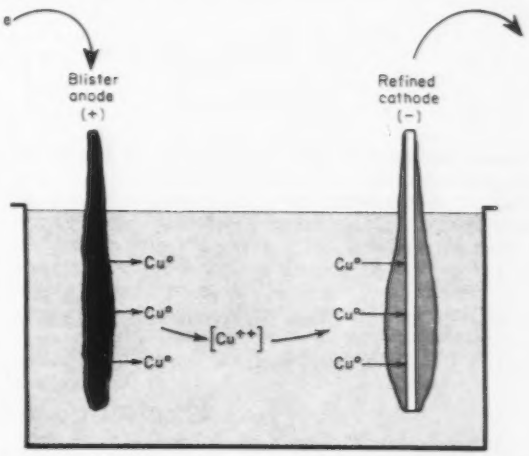
$$2FeS + 3O_2 \rightarrow 2FeO \text{ (to slag)} + 2SO_2\uparrow$$
$$CuS + O_2 \rightarrow Cu\downarrow + SO_2\uparrow$$
$$Cu_2S + O_2 \rightarrow 2Cu\downarrow + SO_2\uparrow$$

Fire refining is necessary to remove arsenic and antimony from the blister copper produced in a converter. Air is blown into molten copper until all the arsenic and antimony have been volatilized as gaseous oxides. Then a green pole is inserted into the melt, where it burns, providing carbon and methane gas which react to reduce oxidized copper back to metal.

Fire refining is necessary a second time if the blister is to be refined by electrolysis and has been melted in a gas-fired or coal-fired reverb, because copper has great affinity for reactive gases—oxygen, nitrogen, etc:

$$4Cu + O_2 \rightarrow 2Cu_2O$$
$$4As + 3O_2 \rightarrow 2As_2O_3 \text{ (gas)}\uparrow$$
$$4Sb + 3O_2 \rightarrow 2Sb_2O_4 \text{ (gas)}\uparrow$$
$$2Cu_2O + C \rightarrow \underline{4Cu}\downarrow + CO_2\uparrow$$
$$4CuO + CH_4 \rightarrow \underline{4Cu}\downarrow + 2H_2O + CO_2\uparrow$$

See separate article in this issue on how Asarco uses an electric furnace to remelt blister for anode production so as eliminate the poling step.



Electrolytic refining of copper involves the use of copper as the anode. Under the influence of the electric current, copper gives up electrons at the anode, enters the electrolyte (sulphuric acid) as an ion, and migrates to the cathode where it gains electrons and becomes metal.

How Organic Resins Recover Metals

ION EXCHANGER organic resins are gaining ground in the industry. *E&MJ* presented a detailed list of resins by metals recovered in *Mid-March 1955 Mining Guidebook*. That list was brought up to date and arranged by resin trade name in *Mid-June 1956 Mining Guidebook*.

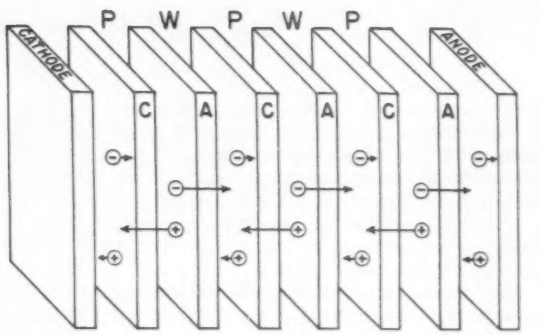
Choice of the name "Ion Exchange" for this metal recovery technique is somewhat unfortunate, since nearly all the techniques discussed so far involve ion exchange; and many of these are far more complex than the simple reactions involving organic resins and metal ions.

Ion exchange resin process involves the exchange or transfer of ions from an aqueous solution to the insoluble resin particle or bead. There are two basic types of ion exchanger resins—cationic and anionic.

Cationic exchanger resins are sulphonic or carboxylic acid resins. Their reaction with metal ions in solution can be generalized as follows:

$$(RSO_3)H + Na^+ + Cl^- \rightleftharpoons (RSO_3)Na + HCl$$

Arrows moving in both directions indicate that the reaction is reversible, i.e., sodium will replace the hydrogen on the resin and can be replaced by the hydrogen of the HCl on the right-hand side of the equation.



Courtesy of Ionics, Inc.

Cationic exchanger resins react with metal ions—thus the name cationic resins—a resin for the ions that would go to the cathode in an electrolytic cell. In general, the higher the valence number (or its oxidation number) on a metal, the more readily it will react with a cationic resin:

Tetravalent ion (M^{++++}) > Trivalent ion (M^{+++}) > Divalent ion (M^{++}) > Monovalent ion (M^{+})

For example, the above series can be extended thus:

$Th^{++++} > Hf^{+++} > Zr^{+++}$
$Ac^{+++} > La^{+++} > Y^{+++} > Sc^{+++} > Al^{+++}$
$Ba^{++} > Sr^{++} > Ca^{++} > Mg^{++} > Be^{++}$
$Ag^{+} > Tl^{+} > Cs^{+} > Rb^{+} > K^{+} > Na^{+} > Li^{+}$

Anion exchanger resins react with free radicals in solution (the nonmetals and metal radicals that would go to the anode of an electrolytic cell). Anion resins are quaternary ammonium or amine resins and react with sodium chloride to extract the chlorine:

$$(RR'_3N)OH + NaCl \rightleftharpoons (RR'_3N)Cl + NaOH$$

The following list shows the free radicals listed in decreasing order of their extraction affinity by anionic exchanger resins:

$OH^- > SO_4^{=} > CrO_3 >$ citrate$^{=}$ > tartrate$^{=}$ > $NO_3^- >$
$AsO_4^{\equiv} > PO_3^{=} > MoO_4^{=} >$ acetate$^-$ > $I^- > Br^- > Cl^-$

Ion exchanger resins are used in columns, baskets (RIP) and in continuous countercurrent columns. According to reports, five Blind River and two U. S. uranium mills are using or will use continuous countercurrent exchange columns. Three systems are popular on North America—the Higgins, Porter and the Techmanix. A fourth system is being developed in Australia.

Ion exchanger resins are now being considered for several new purposes—

Ion exclusion—passing a liquor through a column to separate it into two streams, one containing the cations and the other anions. It can also be used to separate two or more cations into separate solutions.

Ion retardation—a column operation in which alternate portions of pregnant liquor and stripping agent (water only) are passed through a column. Both anions and cations in the feed solution are collected, then washed off with water into a purified, more concentrated solution. With this system, it might be possible to separate two metals by stripping the more easily ionized first, i.e., replace the copper in a copper-zinc extraction with more zinc, then strip the zinc.

Chelating resins are being developed for some difficult metal separations where the metals are too close together in the electromotive series. See chelation.

Ion exchanger resins could be used to extract soluble chelates from solution by the ion exclusion technique.

Ion exchange resins could be used to extract soluble solutions of metal ions and free radicals. Two types of resin sheets are used in the apparatus—one permitting passage of cations only and the other permitting passage of anions only.

Ion Exchange with Organic Liquids

ORGANIC LIQUIDS used in the so-called solvent extraction process react by ion exchange with metal ions (cations) or free radicals (anions) in a solution, just like the organic ion exchanger resins do—in fact, they are for the most part liquid ion exchangers. They are not solvents; nor is the technique really solvent extraction, since ion exchange is involved here (see Parkes Process under gold and silver for an example of true solvent extraction). And just as with the resins, the techniques involved in the use of liquid ion exchangers are much simpler than those used in most of the processes discussed so far.

There are fundamental differences in the reactions of resins and liquid exchangers. Liquids have only been used in acid circuit. Liquids will not extract Group Ia and IIa metal ions as will the resins. Liquids cannot react with these alkali and alkali earth metals because of the electron structure of the metals concerned. Alkali and alkali earth metals have only one incomplete electron shell (the outermost level), and are unable to form coordinate covalent bonds with organic compounds.

Transition metal ions have two incomplete electron shells and are able to form covalent bonds. Rare earth metals have three incomplete electron shells and react readily with organic compounds.

Liquid ion exchangers are used to recover metals from more highly concentrated solutions than those for resins. Also liquids are used for processes requiring the treatment of larger volumes of solution than is the case for resins.

And like their resin cousins, liquid ion exchangers may be cationic, anionic, or complexing or chelating agents.

Cationic liquid ion exchangers are mono or dialkylphosphate esters and react in a kerosene solution to extract metal ions from an aqueous solution:

$$2R_2P(O)OH + UO_2SO_4 \rightleftharpoons UO_2(R_2P(O)O)_2 + H_2SO_4$$

When expanded into its ionic and radical components, the reaction looks like this:

$$UO_2^{=} + 2\left[\begin{array}{l} O \\ \| \\ R\text{-}O\text{-}P\text{-}OH \\ \| \\ O \end{array}\right] \rightleftharpoons \begin{array}{l} O \quad\quad O \\ \| \quad\quad \| \\ R\text{-}O\text{-}P\text{-}O\text{-}UO_2\text{-}O\text{-}P\text{-}O\text{-}R + 2H^+ \\ | \quad\quad | \\ OH \quad\quad OH \end{array}$$

Since the reaction is reversible, the uranium can be

stripped from the solution by adding strong acid. In general, the order of decreasing affinity for metal ions is the same for liquid and resin ion exchangers in the transition and rare earth metal groups.

Anionic or free radical liquid ion exchangers are primary, secondary or tertiary amines, and react to recover anions as follows:

Primary amine

$$2RNO_3 + UO_2(SO_4)_3^{=} \rightleftharpoons R_2UO_2(SO_4)_2 + 2NO_3^-$$

Secondary amine

$$R_2NH + UO_2SO_4 \rightleftharpoons R_2NHUO_2SO_4$$

Tertiary amines

$$R_3N + UO_2SO_4 \rightleftharpoons R_3NUO_2SO_4$$

Again the reaction is reversible, and the uranium can be stripped with lime, carbonate, magnesia or nitrate salts.

Complexing agents—some organic liquids are considered as complexing agents rather than ion exchangers. Salicylic acid used to extract thorium is one such complexing agent. So is tributyl phosphate (TBP) in the recovery of zirconium from aqueous solutions:

$$Zr(NO_3)_4 + 2TBP \rightarrow Zr(NO_3)_4 \cdot 2TBP$$

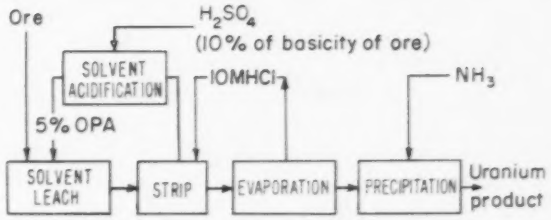
If the zirconium were undesirable, it could be kept in the organic phase by adding fluoride ion which would produce a reversible action:

$$Zr(NO_3)_4 \cdot 2TBP + 6NaF \rightleftharpoons ZrF_6^{=} + 6Na^+ + 4NO_3^- + 2TBP$$

Hydrogen ion concentration or pH is very important in liquid or resin ion exchange. For each metal ion there is an optimum extraction pH that rises from pH 1 toward pH 14 as the metal increases in basicity—according to Crabtree and Lewis in December *Mining Congress Journal*, 1957. Also there seems to be an optimum (reverse) pH for stripping an ion from an organic exchanger. It may be possible to separate a whole spectrum of metal ion from a liquid ion exchanger by proper adjustment of the pH.

Many organic compounds are being used to separate metal ions from solution. *E&MJ* listed some metals and compounds in *Mid-June 1957 Mining Guidebook*.

Char-in-pulp, developed by Arthur D. Little, resembles the char-in-pulp process used by Golden Cycle Corp. to recover gold from cyanide solution. In the Little process, liquid ion exchanger is adsorbed on activated charcoal and added to a slurry which needs no sand-slime separation. Metal ions react with the liquid ion exchanger on the charcoal. It's very much like resin-in-pulp.

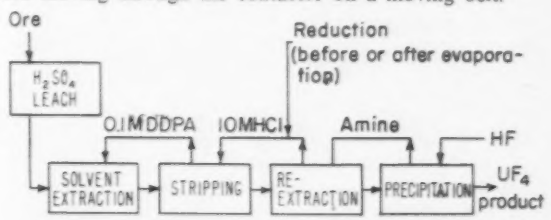


From Ellis, Long and Magner, AIME, 1958

Solvent extraction of uranium ore is suggested by both National Lead and Dow Chemical. Both processes use acids to leach or solubilize the uranium, then extract the uranium ion with liquid ion exchangers. Some water is needed with the acid to leach the uranium. Entrainment losses to date are no better than those for solvent extraction of a thick slurry.

National Lead Process pugs the ore with 10% H_2SO_4, then extracts with tributylphosphate.

Dow Process uses less acid, then extracts with hexane and alkyl phosphate which is sprayed upon the pugged ore moving through the contactor on a moving belt.



From Ellis, Long and Magner, AIME, 1958

Production of green salt (UF_4) has been suggested by Dow Chemical right at the mill instead of yellow cake. Dow first suggested this method in print back in 1955 at the Geneva Atoms For Peace Conference. So far Dow has gotten nowhere with the suggestion.

Process involves a double liquid ion exchange circuit, or a resin and a liquid circuit. In both cases, the uranium can be stripped from the final liquid phase as UF_4 with HF acid:

$$H_{17}C_8-\underset{\underset{OH}{|}}{\overset{\overset{O}{\|}}{O-P-O}}-UO_2-\underset{\underset{OH}{|}}{\overset{\overset{O}{\|}}{O-P-O}}-C_8H_{17}+4HF \rightarrow UF_4\downarrow + R_2P_2O_5H_2$$

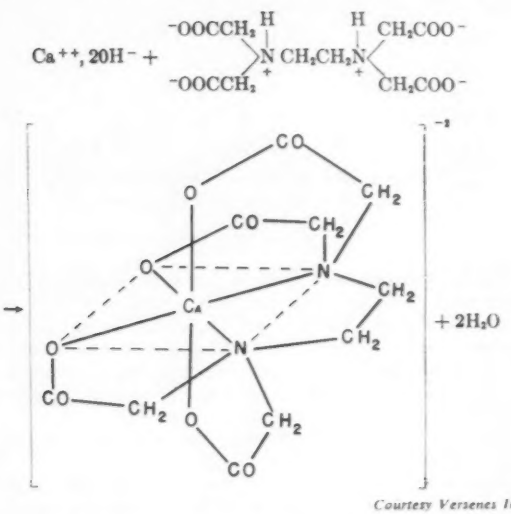
Recovery of metals other than uranium will be forthcoming soon. Dow has suggested possible routes to separate and recover copper, copper and zinc, copper, cobalt and nickel, and titanium from aqueous solutions. Separation of cobalt from nickel may soon be commercial. These are only a few of the developments under investigation.

Chelating Agents Tie Up Metal Ions

LATEST TECHNIQUE in process metallurgy is the use of water soluble organic compounds (polar compounds), called chelating (key'-lay-ting) agents to keep metal ions in solution—to form water soluble complexes. Chelating agents are either polyaminocarboxylic acids or condensed phosphates. Chelating agents are sometimes called complexing or sequestering agents.

Chelates react in aqueous solution to enclose the metal ion within their ring structure (see drawing), forming a stable complex. The name chelation comes from the Greek word kelos or chele, meaning claw—the claw-like action of encirclement.

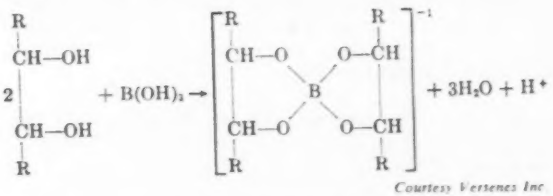
Most chelates are water soluble and used in aqueous solutions. A few are non polar (insoluble in water) and are used as liquid ion exchangers (see above). Others form insoluble chelates at low pH with metals and can be



Courtesy Versenes Inc.

recovered from solution with organic solvents (again, liquid ion exchangers).

Many chelating agents are available which form soluble metal chelates. Dow Chemical Co. has 15 forms under the



Courtesy Versenes Inc.

trade name Versene and Versenol. Characteristics differ with each reagent. Take EDTA, for example. Ethylenediaminetetraacetic acid (EDTA) will chelate ferric ion in acids; precipitate from solution below pH 2; form 1:1 molar chelates; complex metal ions in alkaline solutions. EDTA will not chelate ferric ion above pH 7; will not chelate Ca, Mg, Ba or Sr below pH 5; will not chelate K, Na or Li to any extent. Dow calls this form of EDTA, a Versene acid. American Cyanamid Co. has some chelating agents available in their Cyquest 40 brand name. Cyanamid says that Cyquest 40 is a tetrasodium ethylenediamine tetraacetate.

Where might chelating agents be used? Several uses have been suggested: (1) to tie up or complex an ion in solution so that it cannot interfere in subsequent steps; (2) to purify electrolytes; (3) as flotation deactivators; (4) to remove boiler scale and to leach gypsum from filter cloth.

Blue Sky Metallurgy—Seeking New Approaches

LEACHING WITH MICRO-ORGANISMS, ion migration, chlorination, high-intensity arc melting, solar furnaces, irradiation, and electron-beam melting are only a few of the ways to activate the electron and ion that hold promise for future metallurgical progress.

Micro-organisms can leach sulphide minerals and even manganese oxides. Kennecott Copper reports that bacteria will convert sulphides to sulphuric acid and soluble metal sulphates. U.S. Bureau of Mines has developed four strains of bacteria that will leach manganese. E. C. Perkins and F. Novielli, reporting Bureau research at recent AMC meeting, said that preliminary cost estimate for bacteria leaching of manganese would be in the order of $1 a unit on 4% Mn ore.

Ion migration or electrophoresis has been used to separate isomers of organic chemicals on a small scale. It has also been used by the analytical chemist to separate metal ions in electrolytes. For example—mixed ions of Co, Ni and Cu dissolved in sulphuric acid when passed through two platinum electrodes (laid on a wet blotting paper between two sheets of glass) will migrate toward the cathode under the influence of a low-amperage high-voltage dc current. Copper will migrate to one position, cobalt to another, nickel to still another, depending on the electronegativity of each metal ion.

Ion migration might be used to upgrade a solution or to separate metals in the solution.

With elemental chlorine available at reasonable prices today, many metallurgists are turning their attention to the use of chlorine as an extracting agent. FluoSolids reactors, blast furnaces, retorts and flash smelters can be used to concentrate ores by chlorination.

High-intensity arc melting is being pushed by Vitro Corp. using the Sheer-Korman Process which boils metal ions off ore-coke electrode at up to 10,000 deg C. Metals can be recovered as oxides or halides, depending on furnace atmosphere. And they could be influenced by electric or magnetic forces at the same time.

Solar furnaces, which focus the sun's rays to melt metals, are being developed in the U.S. and France. Kennecott Copper has a small unit that can produce temperatures to 5000 deg F. French researchers have a working 60-kw model that can melt 500 lb of steel a day. They are building a 1000-kw furnace. Temperatures up to 90,000 deg F have been reported. French team is betting that a solar furnace in a high-intensity sunlight area could compete with an electric furnace in a low-cost hydroelectric area.

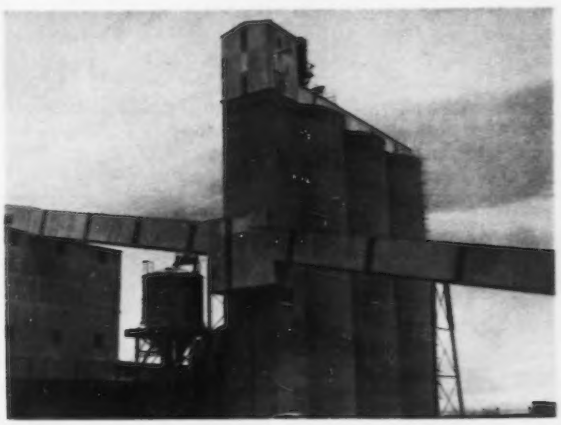
Irradiation with cobalt-60 will convert low-grade coals to bituminous, says a U.S. Navy report. Similar benefits might accrue from irradiating an ore, a concentrate or a matte.

Electron-beam melting under vacuum produces high-purity metals, according to Stauffer Chemical Co. Heat to melt the metals is provided by an electron gun that serves as the anode, with the metal as cathode. Reactive metals can be purified; high melting point metals can be refined; gaseous impurities can be boiled out; zone refining can be done faster, cheaper. Stauffer reports that tantalum can be refined in the furnace at 7 kwh per lb of metal refined, as against 500 kwh per lb when the metal is solid-state sintered in ordinary practice. Stauffer suggests that pure ductile chromium may result from this work.

What new, fantastic processes will be developed in the next few years? Technology is moving too fast even to make a guess—but this much is certain, the metallurgist will keep on trying to find a better, faster or cheaper way to make the electron and ion move to his advantage•

Between pit . . .

. . . and product



U. S. Borax Has Integrated a Complex Industrial Plant

A TREMENDOUS BLAST in the Boron pit of U.S. Borax & Chemical Co., detonated Nov. 13, 1957, signaled the beginning of an open pit-crushing plant-refinery complex unique in industry history. The blast took place at the dedication of the new $20-million facility on signal from James M. Gerstley, president of the company, to Undersecretary of the Interior Hatfield Chilson, who officiated.

In full production, the new pit developed at a cost of about $3-million to exploit the largest high-grade sodium borax deposit in the Free World and the adjacent refinery covering an area of 80 acres add 30% to the corporation's current production. Although the actual refining processes employed in the new plant follow closely those used in the corporation's Wilmington, Calif., refinery, the open-pit mining operation is unique and a "first" to the boron industry. The extra plant production will greatly help fill the ever-increasing demand for boron on the part of industry and for defense. As designed, the plant facilities now in operation could be increased considerably for a comparatively small additional capital investment according to the designers of the installation.

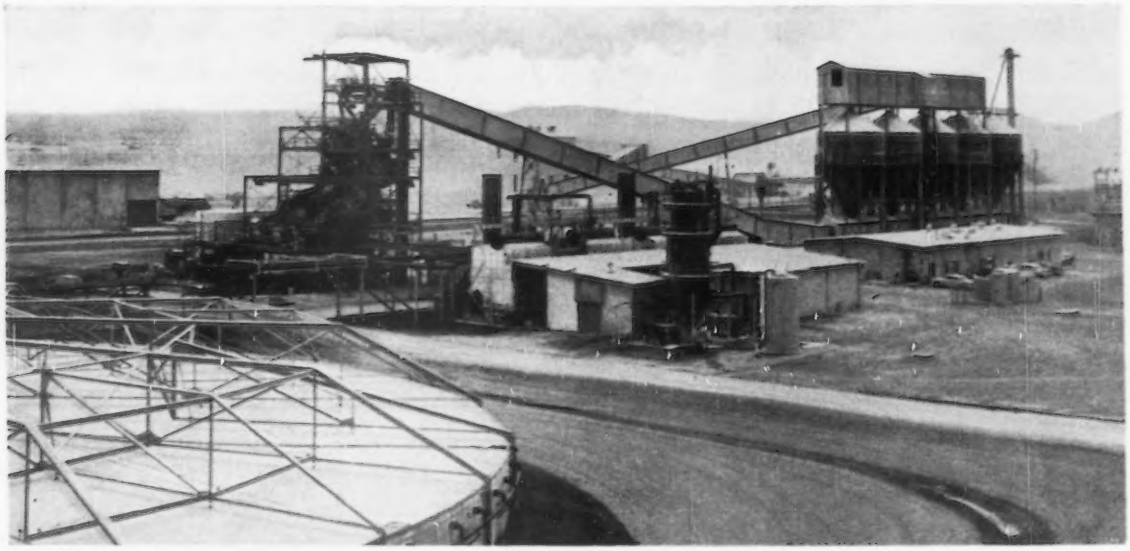
Not so many years ago borates were regarded simply as household cleansing materials. Early production in California came from high-grade colmanite deposits occurring in the Death Valley area, the mine output being transported to the rail shipping point at Mojave by the famous 20-Mule Team borax wagon trains. Coincidentally, the travel route taken passed in part over the vast sodium borate deposits now under exploitation at Boron. Yearly mine output was relatively low and the cost of refined borax high.

Boron has come a long way since then. Annual production in the United States has increased from a meager 8,000 tons in the late 1890's to more than 900,000 tons in 1956. It is estimated that the 1-million ton mark was topped in year 1957. In 1864, when the first borax operations started in California the price per ton of borax in New York was $780.00. Today, the company receives $45.00.

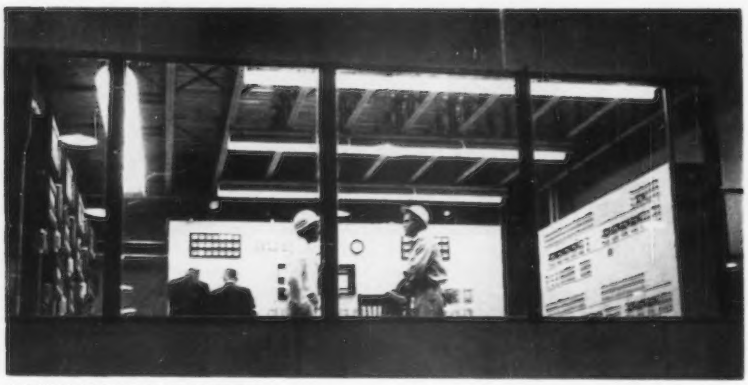
Borax and boric acid are used today in the manufacture of a wide variety of products by more than 100 different industries. These include pharmaceuticals, porcelain enamels, plastics, steel, glass, ceramic glazing, agricultural chemicals, flameproofing, fire extinguishing, and gasoline additives. In national defense boron has become an important factor because of its possible use as an essential ingredient in high energy fuels for airplanes and rockets.

The sodium deposits of U. S. Borax are in the Mojave desert at Boron, a modern settlement 130 miles northeast of Los Angeles. Discovery dates back to early 1925, when drillers working under the direction of the late Clarence Rasor brought up from a depth of 380 ft sodium borate, known today as kernite. The company had been interested in the area ever since Dr. John Suckow accidentally struck colmanite there in 1913.

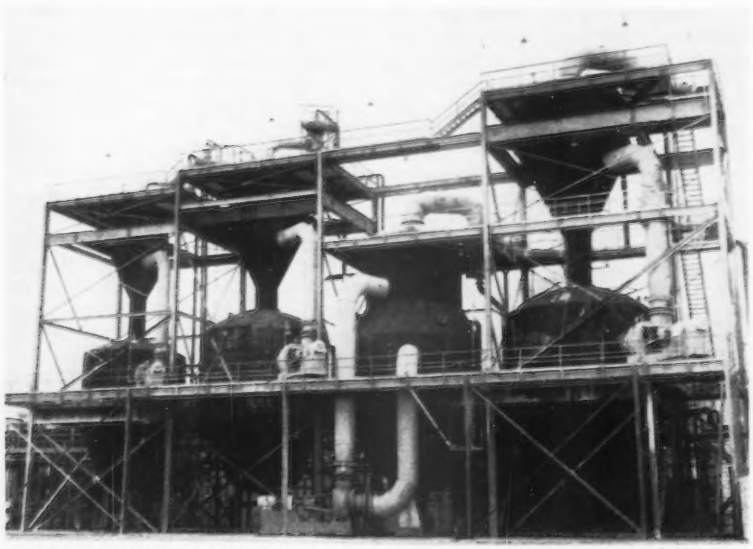
Immediately after purchase of the holdings, the company sank a shaft in 1926, followed later by installation of a mill. These meager beginnings were expanded during the ensuing years into three producing mines, the Baker, West Baker, and Jenifer, served by a total of seven shafts and appropriate



PIT ORE is treated successively in the primary and secondary crushing plants (center background), blended, and stored in four of the five 1,000-ton fine ore bins at right, and dissolved at the plant at left. Thickeners follow.



CENTRALIZED CONTROL is used extensively in the Boron operation. Supervisors above are keeping close check on flow in the granulating plant facilities.



GRANULATING PLANT is headed by four vacuum crystallizers which handle filtered solution from thickeners. Largest unit is 85 ft high, holds 95,000 gallons.

crushing, concentrating and magnetic separation plants and units for the production of various borate products. Early mining methods followed closely those employed in metal mines, chiefly open stope or shrinkage stope. The room-and-pillar method of stoping with Joy continuous miners, shuttle cars, and belt conveyor haulage was used in the Jenifer mine which went into production in 1951. All underground mining ceased soon after the pit under development reached the production stage in 1957.

The Boron borate ore beds occur at depths from 130 to 1,000 ft. below the surface. Overlying the ore zone is a layer of alluvium ranging in thickness from 100 to more than 400 ft. Below the overburden the ore zone is interbedded with Tertiary shale, with the shale envelope protecting the borate from action of ground water. Average concentration of boric oxide (B_2O_3) throughout the deposit, estimated to contain more than 80-million tons, runs about 25%. Selective mining practiced underground provided a plant feed averaging 28%. The deposits are the most extensive on the North American continent, containing about 70% of the nation's high-grade reserves. At the current rate of consumption this supply alone will fill the needs of the entire world outside the Iron Curtain for defense and industrial purposes for more than 100 years. The U.S. accounts for 90% of the world's boron output at the present time, according to official estimates.

Management had realized for a number of years that open pit mining of its Boron deposit would have several advantages but demand levels and machinery available did not make such

a project attractive. Underground mining costs, especially in the mechanized Jenifer mine, were satisfactory, though ore recovery was low because of the large horizontal and vertical pillars required. However, the picture changed with the advent of improved open pit techniques and equipment and availability of concentrating and refining facilities capable of processing the lower grade ore that would result from mining the entire deposit. The large open pit now in operation is the result of extensive economic and engineering studies made by the company's executive and mining departments.

The Pit

As designed, the pit is more or less oval in shape, measuring some 1,400 ft across the maximum diameter. Entry is by spiral system, and over-all pit slope will be 1.4:1. Haulage roads are established at minus 7% grade. Preliminary development work involved removal of more than 9-million tons of overburden made up of alluvial gravel and sand, tuffaceous sandstone, conglomerate, sandstone, limestone and shale. As mentioned previously, the overburden is quite thick, but so is the ore zone, giving a favorable stripping ratio. Stripping operations were started under contract by Isbell Construction Co. of Reno, Nev., in January 1956, and the first ore was encountered at a depth of 137 ft in April 1957. Equipment used in this work included Euclid S-18 and 12TDT scrapers, Caterpillar D9 tractor pushers, and D9 tractors equipped with ripper. Haulage distance from pit floor to dump is about one mile. A part of the overburden was used for construction of dikes to protect the pit from flash floods and to dam the tailings area.

Ore mining and additional stripping required is now done by the company. In the ore production zones benches are carried at a height of 30 ft. Blastholes are drilled about 5 ft below grade, or to a depth of 35 ft. This is done with a truck-mounted McCarthy unit using 4⅝-in. Austin Powder Co. auger drills with tungsten carbide finger bits. Drilling speed averages 12 fpm plus. Spacing between holes is 16 ft and distance from the bench crest about 12 ft. Blasting is done with fertilizer-grade ammonium nitrate received in 80-lb bags, 4-in., 10-lb EP-203 primers, and 50-grain Primacord. Three quarters of fuel oil are added to each bag before it is poured into the blasthole. In general, one bag of powder is used per hole, the stemming required consisting of drill cuttings. Loading procedure is as follows: One-third of an 80-lb powder bag is poured into the hole first, followed successively by lowering Primacord-suspended primer, pouring remaining two-thirds of powder bag, lowering one-half of a Primacord-suspended primer, pouring stemming, and stringing Primacord trunk line. Detonation is effected by electric blasting box. Experiments with Primacord line (50 grain), fitted with 1-ft lengths of 400-grain Primacord on 3-ft centers to detonate the blasthole charge have been very satisfactory. It is planned to adopt this method, eliminating the use of primers.

Broken ore is loaded into Kenworth 802 rear-dump trucks by 3-yd B-E 54-B electric shovels for transportation to the primary crushing plant at the head of the refinery. Operations at each shovel station follow conventional practice of backing in trucks on either side of the shovel constantly, one being loaded, one waiting. Haulage distance to the primary crushing plant is .7 mile. In the stripping zones the company now employs a fleet of eight Euclid SS24 scrapers and auxiliary Caterpillar D9 tractor pushers and D9 tractors with rippers. Road grader and sprinkler truck units are operated on set time schedules to keep haulage roads in top condition. Pit equipment is serviced and repaired in well-equipped shops a short distance from the pit.

The Refinery

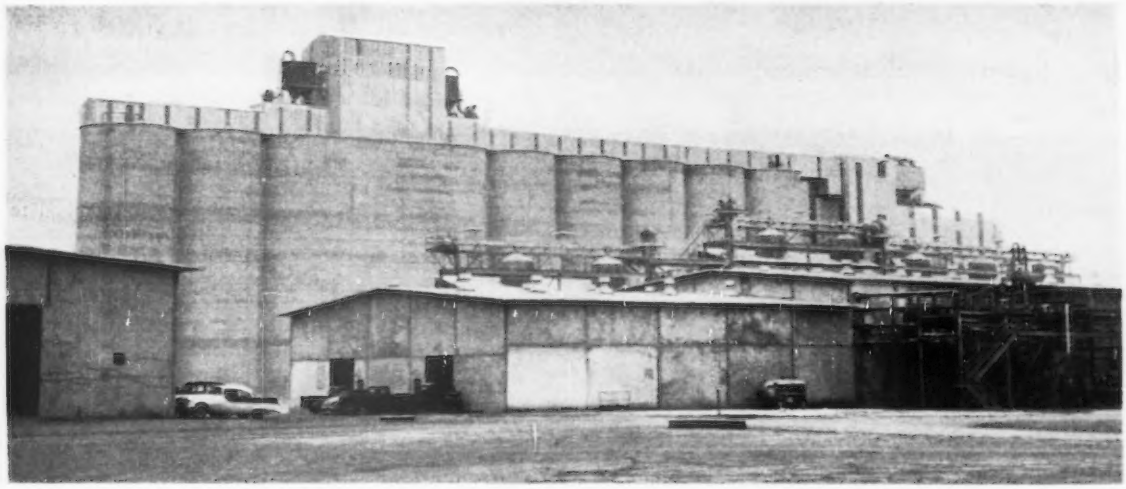
Decision to build the new processing facilities at Boron was dictated by two prime factors—(1) shipping the lower grade pit ore with its higher percentage of gangue to the 30-yr old Wilmington refinery some 150 miles distant would result in higher freight rates, and (2) a difficult waste disposal problem existed at Wilmington. Also, the possibility that the concentrating operation at Boron and the refining operations at Wilmington could be combined so far as ore handling, product loading, and others were concerned presented a very attractive picture. Operations at the Wilmington refinery are geared to the higher grade ore obtained by selective mining carried out in the underground mines at Boron. The 700-ton mill at Boron produced ore concentrates by an entirely dry process involving reduction in rolls and hammer mills, sizing on vibrating screens, and removal of shale or gangue on high intensity magnetic separators, and treatment in rotary dryers to effect a reduction from a 10 to 5 mol hydrate. A special plant reduced the dried magnetic concentrates to a completely anhydrous product.

Save for larger and more fully automated processing equipment, operations carried out in the new refinery follow closely those employed at Wilmington. Briefly, they consist of dissolving the blended ore; separating the borate-rich mother liquor from clay by countercurrent decantation; crystallizing, centrifuging and drying the sodium borate decahydrate and pentahydrate thus obtained. In addition to these basic plant operations, various auxiliary plant units have been engineered, including a water supply system and a separate fusing plant for the production of anhydrous borax. Solid materials are handled throughout the plant by an extensive belt conveyor system containing belt units ranging in width from 12 to 42 in.

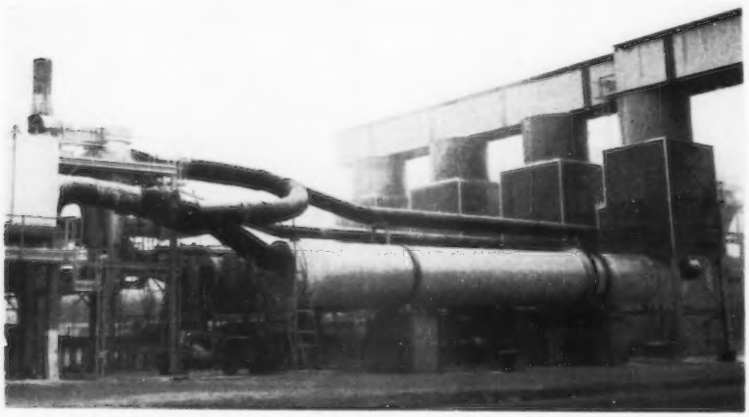
Blending and crushing. Blending of the mined ore starts at the pit. By operating the shovels at different horizons simultaneously (boric oxide content of stratified beds of borate and clays varies from layer to layer) and sending alternate truck loads to the primary crusher, the boric oxide content can be kept within a range of several percent. However, this is considered inadequate for the purposes of the plant and further blending is done after crushing.

Pit ore is reduced to plant feed in two stages. Primary crushing to 4 in. is done in a 42x66-in. hammer mill type crusher served by a truck dump bin and vibrating feeder a short distance from the pit. This unit will eventually be moved to the bottom of the pit with belt transport to the refinery. Crushed material is transported via belt conveyor to a stockpile area 730 ft long and 112 ft wide at the base with a reclaiming tunnel, a 10-ft diameter corrugated steel tube 800 ft long buried one ft underground equipped with 16 draw points and housing a 30-in. belt conveyor leading to the secondary crushing plant, in the center. Capacity is about 60,000 tons. Here, the ore is distributed in horizontal layers by a mobile stacker which may be set to automatically cover any portion of the pile. Tip of the boom is 45 ft above ground.

Ore withdrawn through the reclaiming tunnel is belt-conveyed to the secondary crushing plant where an impactor type crusher operating in closed circuit with two vibrating screens with ¾-in. openings reduces it to minus ¾-in. refinery feed. The plant also contains an elaborate continuous sampling system. Crushed ore goes via belt conveyor to four elevated cylindrical steel bins, each having a capacity of 1,000 tons. A fifth bin is available for storage of soda ash which is dissolved with borax to replace calcium in the ore and prevent lime de-



RASORITE 46 output and 5 mol refined borax are stored in nine reinforced 100-ft concrete silos. Total storage capacity is 19,700 tons. Three other silos store anhydrous borax. Shipping is from warehouse via the Santa Fe Railroad.



REFINED PRODUCT from the granulating plant is dried in rotary, gas-fired units preparatory to fusing in furnaces to produce Rasorite 46 anhydrous borax.

OTHER DRYING UNITS are maintained at the south end of the granulating plant. These Wyssmont Turbo driers take centrifuged crystals from the granulator.

posits in the dissolvers ahead and pipe lines.

At the dissolving plant, crushed ore is mixed with the weak borax solution or mother liquor returning from the granulating plant and agitated and heated in a series of steam-jacketed, mechanically agitated tanks containing steam coils, each of 2,000 gal capacity. Insoluble rock and clay particles present in the resultant solution are separated by passing the near boiling solution over a vibrating screen. They range in size from ¾ in. to about 60 mesh. The screen undersize, a muddy solution containing the fine gangue materials is pumped to the thickening plant.

The four thickening plant units available operate on the countercurrent system employed in cyanide plants handling gold-silver ores. Each thickener is 230 ft in diameter and 8 ft high and can hold 3½-million gal. Bottoms are made from ¼-in. plate and the sides and roofs from ⅜-in. steel plate. The roof and insulation keep solutions at temperatures more than 200 deg F. Thickener underflow is pumped from thickener to thickener and washed each time by a weaker borax solution and finally by water to give maximum recovery of borax. Concentrated solution is pumped to the granulating plant.

Granulating plant. Solutions received from the thickening plant are treated in three plant circuits, each making a different type of borax. Two of these produce refined borax, requiring filtering of feed solutions in clarifiers (leaf filters) before they are pumped to the respective crystallizer unit. There are

four crystalizers available, one for each circuit and a spare which may be substituted for any of the other three. In these units the solutions are cooled and concentrated by the evaporation of water under vacuum. The crystals formed will grow by circulation until they are large enough to settle to the bottom of the crystallizer. These are subsequently separated from the vacuum crystallizer solutions by means of automatic centrifugal baskets, of which there are 16 operating inside the plant. After centrifuging the surface moisture is dried from the borax crystals in five Wyssmont Turbo dryers installed along the southern wall of the plant building. Steam heated, these dryers consist of a series of horizontal revolving trays, with the borax being raked from one to the next below and turned for moisture removal in the process.

Anhydrous borax plant. Here, the refined borax is first dried in four rotary kilns and then fused in four gas-fired furnaces to produce anhydrous borax. The molten borax discharging from the furnaces is cooled on chilling rolls and while passing over 3x60-ft Carrier vibrating cooling conveyors. The final plant product after cooling is ground and screened to specifications set by various customers.

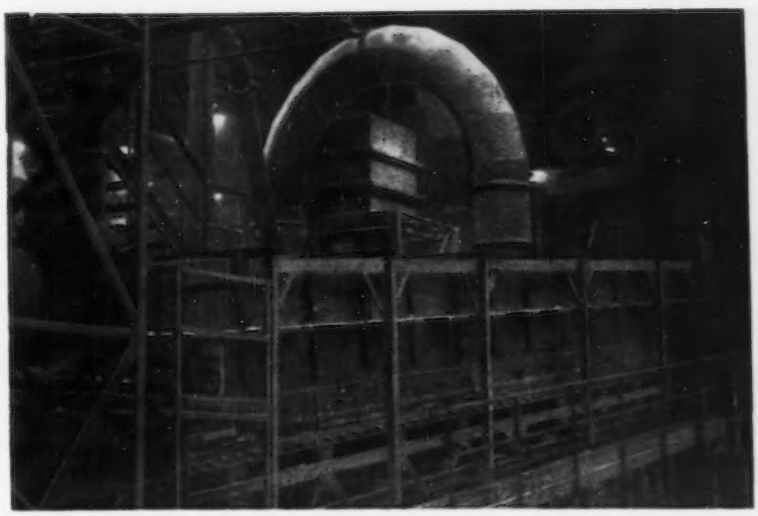
All plant units described use central control rooms for optimum supervision. Instruments control and record data from critical points in the process such as temperature, pressure and rate of flow of material. Ruby lights indicate which equipment is running, and which is not.

Storage and loading plant. The 12 silos, each 100 ft high, available for bulk storage of finished products are of reinforced concrete construction. Six silos used for storing Rasorite 46 have a capacity of 13,400 tons, three for 5 mol refined hold 6,300 tons, and three for Rasorite 46 anhydrous borax about 6,900 tons. Shipping of products is done both from the silos and from warehouses just south of the silos. A short spur connects the plant with the mainline of the Santa Fe R. R.

Auxiliary installations serving the refinery include an administration building, modern repair shops, supply warehouse, laboratory, boiler plant, paint and carpenter shop and lesser facilities. A 1-million-gal water storage tank on the ground and a 100,000-gal elevated steel tank (120 ft high) provide line pressure throughout the plant. The project described in the foregoing account was a designing, engineering and construction joint venture of Southwestern Engineering Co. and Twaits-Wittenberg Co.

80-ACRE COMPLEX of pit and refinery at Boron, Calif. represents more than two years' effort by U.S. Borax and expenditure of some $20-million.

PIT WAS THE BASIS for U.S. Borax's move of equipment from Wilmington, expanded processing facilities. Mining was previously done underground.



MOLTEN BORAX from the fusing furnaces travels over "chilled rolls" and then along a Carrier cooler conveyor (above) where an air stream is blown across it.

Forecast of Nickel Production to 1980 Based on Projection of Mean Trend

F. C. FEARING

AFTER WORLD WAR II, long-range forecasts were published with increasing frequency in many fields, such as growth of populations, production trends for important metals, the expected expansion of power needs, etc. During this period some old techniques were put forward and labeled "new" which had long before been tried and found unreliable. In short, the problem of establishing long-range trends seemed to be in a state of flux when the writer was first commissioned to develop rational forecasts for several of the metals to 1980, on a "Free World" basis. These earlier metal forecasts were followed by studies of the expected expansion of power needs for the United States and for Power Region VII (the Pacific Northwest). Subsequently, when these power curves were compared with forecasts by the Federal Power Commission, they were found to be in close accord.

Rising population trends have long been recognized as the compelling force back of rising demand and expanding production. To secure needed financing of new situations or plant expansions, public utilities early realized that they must be able to show a dynamic population trend over the franchise area, projected a decade or more into the future, during the period of bond amortization. Population trends are no less important with respect to the future of any other commodity or service. If people do not want a given item, its promotors will not prosper. Thus, it became apparent that it is not enough to tie production into the population trend alone, but in addition it should be tied into a sound and practical index that shows the trend of the use of the item under discussion by the population affected. And finally, the methods developed should be as free from the human judgment factor as can possibly be achieved. The procedures developed for long term forecasts will now be described for nickel and will be followed by detailed essential comments: (Refer to Chart).

Fundamental Statistics

(a) World Population. Table I (at right) provides the figures of the world's population from 1920, and the forecast to 1980 as determined by the United Nations after a long and intense investigation, to which most of the world's governments contributed. This has been plotted on the chart as Curve A. It is remarkably uniform, compared with population curves for political subdivisions, which display much greater fluctuations. The regularity of the world curve, A, may be explained by the fact that on this broad basis a set-back in one sector is likely to be offset elsewhere.

(b) Free-World Nickel Production. Table II, shows the historical statistics from 1920 through 1956, obtained from the U.S. Bureau of Mines during July 1957. It is a revision of former statistics that had been questioned in testimony taken by the Johnson Committee of the U.S. Senate. The figures in Table II have been generally accepted in the industry.

(c) Analysis of Nickel Statistics: Inspection of the chart shows that the statistical record is divided into five segments:

(1) The period 1921-1929, inclusive, marking the recovery from the War I recession.

(2) The "1929 Depression" which ended in 1932.

(3) The Recovery of 1933-1937 inclusive, which culminated in a sharp set-back in 1938.

(4) The period of World War II, 1939-1946 inclusive.

(5) The post-World War II recovery of 1947 through 1956.

Even a cursory inspection of Curve B will show that: Segment (1) has no bearing on our present post-World War II economy. Nor does Segment (2), the Depression period, have any resemblance to the post-World War II situation. Segment (3), however, demonstrated the potential strength of nickel for expanded production in a peaceful world. Segment (4), the World War II years, is obviously an abnormal one. Segment (5), the most recent period, has shown a persistent and high rate of expanding production over a 10-year stretch. World War II ushered in a metallurgical revolution, with the accent on super-high temperature metals for the "Jet Age." It also demands special metals and alloys to meet needs of atomic and "space" developments. In these categories, nickel has played an important part and will doubtless continue to do so.

During Segment (3), it is to be recalled that there was no "Atomic Age," no "Jet Age" and no "Space Age." Therefore this segment has no economic parallelism with Segment (5) of any compelling importance.

Table I. World Population

(Chart Curve A)

1900	1,608,000,000	United Nations, Carr-Saunders Estimate
1905		
1910		
1915		
1920	1,834,000,000	United Nations—
1925		"The Determinants and Consequences of Population Trends" (Table 2, Page 11, 1953)
1930	2,008,000,000	
1935		
1940	2,216,000,000	
1945		
1950	2,454,000,000*	
1955	2,603,000,000	United Nations—
1960	2,769,000,000	"Framework for Future Population Estimates" (Population Division)
1965	2,951,000,000	
1970	3,153,000,000	
1975	3,378,000,000	
1980	3,628,000,000	

*Revised figure. Received from Mr. Grauman of the U. N. Nov. 1, 1954.

Table II. Free-World Nickel Production— Net Tons*

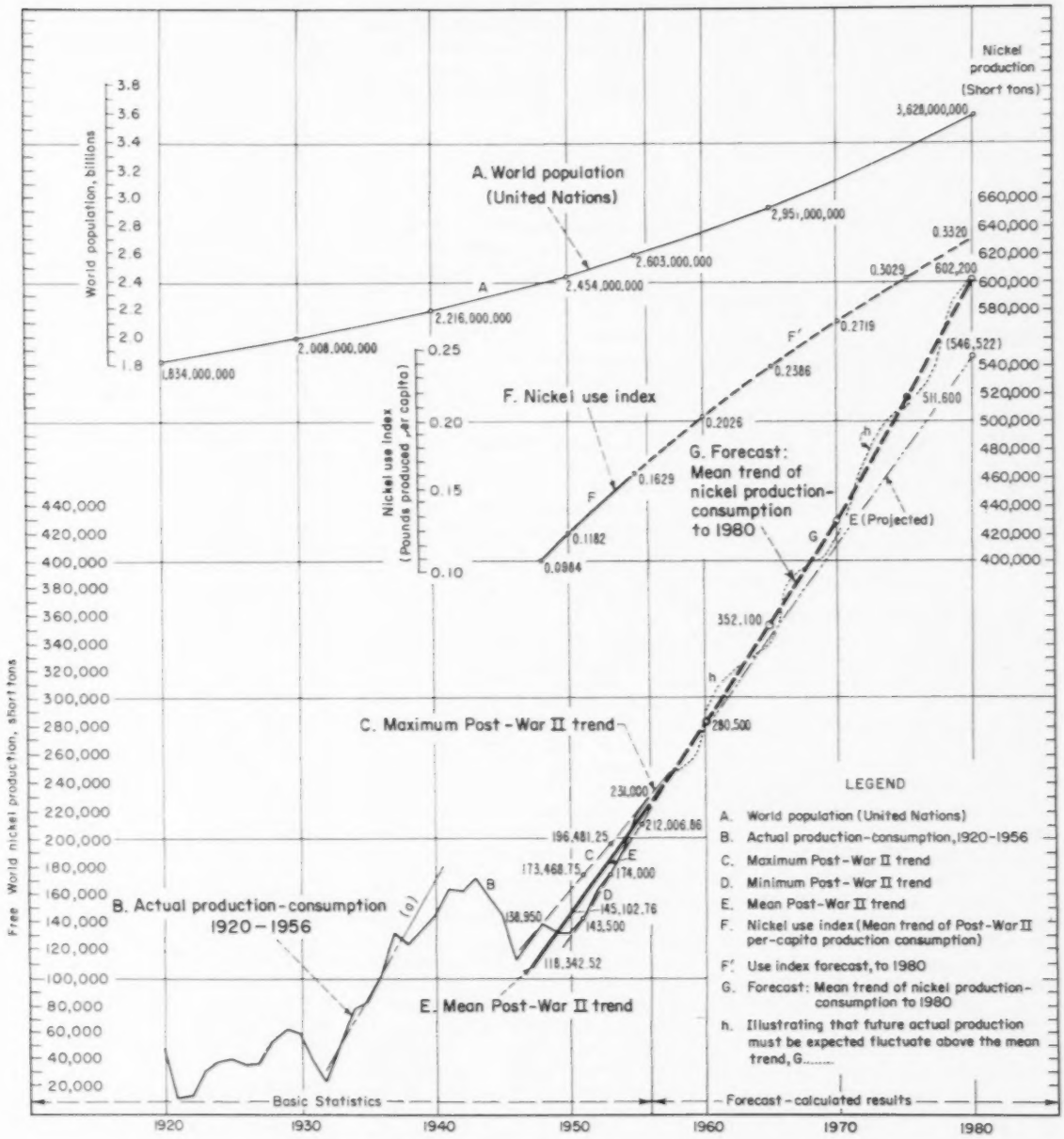
(Chart Curve B)

Year	Production (Net tons)	Year	Production (Net tons)
1920	31,500	**1939**	134,500
1921	8,850	**1940**	144,770
1922	17,755	**1941**	163,600
1923	37,245	**1942**	162,070
1924	38,500	**1943**	171,800
1925	40,919	**1944**	158,770
1926	37,360	**1945**	145,030
1927	38,030	**1946**	113,600
1928	55,400	**1949**	126,750
1929	62,100	**1948**	138,950
1930	59,800	**1949**	133,350
1931	40,000	**1950**	132,450
1932	24,040	**1951**	143,500
1933	51,000	**1952**	161,000
1934	77,950	**1953**	174,000
1935	82,280	**1954**	192,000
1936	100,750	**1955**	215,000
1937	132,200	**1956**	231,000
1938	124,550		

*Figures from U. S. Bureau of Mines July 8, 1957.

Consultant, formerly on Ventures, Ltd.'s, staff.

Free-World Nickel Production-Consumption, 1920-1956, and Forecast to 1980 With World Population, 1920-1980 as Determined by United Nations and Resulting Per Capita Production-Consumption 1946-1980



It is therefore apparent that Segment (5), for the ten post-World War II years, provides the only logical set of figures for use in developing a long-range forecast. Hence, it should not be contaminated with any earlier statistics.

Procedures: In accordance with the foregoing analysis, the discussions that follow are based upon the post-World War II period, 1947-1956, inclusive, the figures being in net tons of nickel production from Table II. Our first objective is the mathematical development of the Mean post-World War II trend, shown as Curve E:

(a) Maximum Trend (Curve C) is fixed by the nickel production of 138,950 and 231,000 net tons for 1948 and 1956, respectively. Its equation is:

$$Y = \frac{92{,}050\ (X) - 3{,}306{,}800}{8}$$ in which X is the number of years since 1900, and Y represents nickel production in the Free World, in net tons.

(b) Minimum Trend (Curve D) is determined by the years 1951 and 1953, when nickel production in the Free World was 143,500 and 174,000 net tons, respectively.

(c) Mean Post-World War II Trend will obviously be a curve half way between Curves C and D. A pair of

points with one point on C and the other on D when added together and divided by 2, will provide a point on the required Mean Trend line (Curve E). Similarly, another pair must be found in order that Curve C may be fixed.

It will be observed that we have two points on Curve D for the years 1951 and 1953 and that, from the equation of Curve C, we may calculate the values thereon for 1951 and 1953. These are found to be 173,468.75 and 196,481.25 net tons, respectively. The average of these respective points is then as follows:

	1951	1953
Points on C:	173,468.75	196,481.25
Points on D:	143,500.00	174,000.00
Required Points on E:	316,968.75 / 2	370,481.25 / 2

So that E, the Mean post-World War II Trend, is fixed by:
158,484.38 and 185,245.63 net tons

The equation of Curve E is found to be:

$$Y = \frac{26{,}761.24\ (X) - 1{,}047{,}854.48}{2}$$

The Mean Use Index: As stated toward the end of the introduction, it is essential to develop the Mean Use Index. Whereas, Curve E, is the Mean Over-all Trend from 1946 to 1957, it must per se, include the Use Trend as a hidden factor. Obviously, also, it cannot go on reflecting such a factor beyond the year 1956.

Since we have population figures within the post-World War II period, for the years 1948, 1950 and 1955, we may use the equation for the Mean Trend, E, to calculate the average production along this line for the foregoing three years. These calculated figures amount to 118,342.52, 145,102.76 and 212,066.86 net tons, respectively, and are equivalent to 236,685,040, 290,205,520 and 424,012,720 pounds of nickel. These latter when divided by the populations, for the respective years, provide the three points from which Chart Curve F was plotted, giving us a rational index of the trend of the use of the metal, or the "Use Index." Furthermore, since Curve F is predicated upon the Mean post-World War II production trend, E, it must also represent the Mean Use Trend.

Use Index Equation: Up to this point all derived figures have been predicated entirely upon the historical statistics, 1947-1956 inclusive. In order to proceed with the forecast to 1980, it is necessary to develop the equation of F from which the Use Trend beyond 1956 may be calculated.

Curve F is not a straight line, (as is curve E), but is a segment of a parabola, symmetrical to the X-axis and opening to the right. If we let (X) represent the number of years since 1900, and (Y) the Index Figure (Pounds of nickel per capita), the equation of Curve F will be found to be:

$$Y = \frac{\sqrt{672.168(X) - 22.720.4276} - 64.6202}{336.084}$$

Use Index Forecast: Using the equation, the Use Index values for 1960, 1965, 1970, 1975 and 1980 were found to be as shown on Curve F. The curve displays a persistent and dynamic growth beyond 1956 in the use of nickel, with only a slight and gradual reduction of the rate of increase of the index along the way.

Mean Nickel Forecast: Computation of the final forecast (Curve G) is now a simple matter: If we multiply the index figures by the populations for each corresponding year and divide the results by 2,000, we will obtain the net tons of nickel production given on Curve G, from which it was plotted.

It seems worthwhile to emphasize again that Curve G represents the Mean Trend, or Axis of future nickel production, with respect to which actual future statistics will be expected to fluctuate. This has been illustrated by the light, dotted Curve (h), to which no numerical values can be assigned. Should actual production for any year in the future happen to coincide with either Curve G or Curve (h) it would have no significance, as it would be entirely coincidental.

In general terms, Curve G indicates that the Mean Trend or Axis, of nickel production will be nearly double its 1956 figure by 1970, and may be expected to be 2.6 times greater by 1980, reaching 602,000 net tons in that year. Furthermore, it should also be noted that Curve E is not valid beyond 1956 and that Curve G has no validity prior to that year, at which point they become mutually tangent.

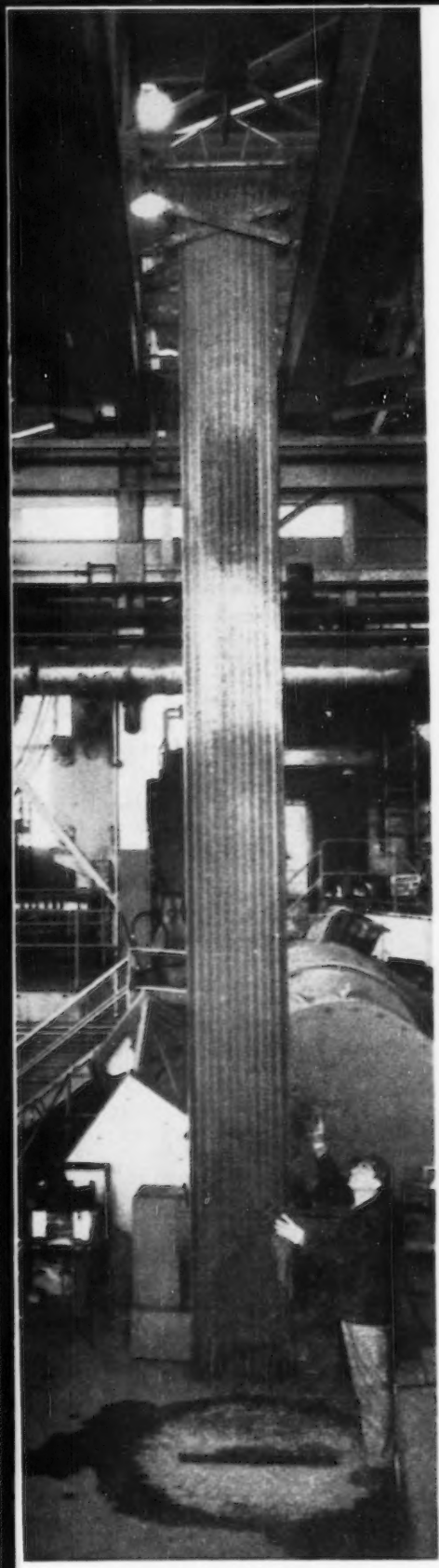
The nickel forecast herein presented, has been developed by mathematical methods all the way through, by-passing the human-judgment factor in so far as the writer is concerned. How much, if any of such factors entered into the compilation of the basic statistics we have no way of knowing. It is to be assumed that they are truly in line with the facts. It should also be noted that the forecast is not designed as an attempt to "pin point" any future results. Our studies have convinced us that such attempts are extremely dangerous. There are too many imponderables in the situation, especially those arising from international politics, to warrant such objectives. But, as has been shown, it is perfectly rational and practical to develop a mean forecast trend based upon a definitely pertinent statistical period.

Other methods: Quite a few forecasts that came out about the middle of the present decade were based on the logistic equation. In this regard it is well to quote Palmer C. Putnam, Consultant to the Atomic Energy Commission. On page 281 of his "Energy in the Future" he states: "At the same time Hart has illustrated in other fields what Pearl and Reed found in populations—that the logistic is valueless as a predictive device. It may "explode", break into "ripples", or develop successive "surges". We also explored the validity of logistic methods at the Mathematics Department of Columbia University with reference to its essentials and limitations. Prof. A. P. Hillman remarked that he could give the same data to a half dozen advanced post-graduate students and receive almost as many different solutions. This is because the procedure involves "curve fitting" that necessitates a degree of human judgment.

Importance of the Use Index: Even before World War I, engineers dealing with public utility reports with respect to further financing, would first find the mean trend over the required period, which would be a straight line, similar to Curve E. This would then be projected on its course over the amortization period. It will be noted on the chart that if this were done in the case of Curve E, it would indicate a nickel production of only 546,522 net tons in 1980. However, when the trend takes into account the growing use of nickel, Curve G reaches 602,200 net tons in 1980—or 55,678 net tons additional. Thus, forecasts that do not take the Use Index into account would be too low where there is an increasing use of the item, as in the present case. But there are other situations where the use of metal per capita is falling off. In this instance any forecast that ignored such a condition would be too high.

From a financial standpoint, a forecast upon which important investments may be predicated should be one involving a fundamentally sound "calculated risk". Such a forecast will not pretend to pin-point future results, nor to trace any maximum curve. It

(Continued on p. 148)

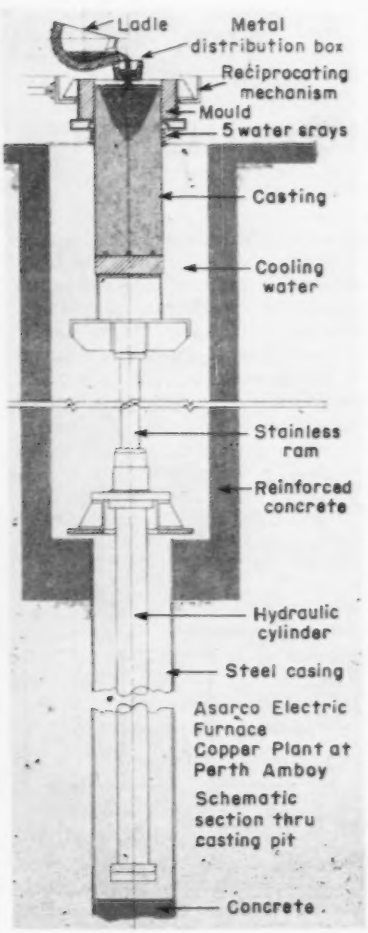


COPPER industry's largest cakes are pulled from Asarco's vertical molds.

Asarco's Semi-Continuous Casting of Copper Cakes

FOLLOWING on the heels of the January installation of an electric furnace to melt copper cathodes, American Smelting & Refining Co. has installed a continuous wire bar wheel and a semi-continuous cake casting unit at Perth Amboy.

Electric melting of cathodes from the electrolytic refinery does away with the poling step required when copper is melted in a coal- or gas-fired reverberatory furnace. Copper has great affinity for active gases and reacts with these gases in the ordinary reverb practice. But copper melted in an electric furnace needs only to be covered with charcoal to protect it against the atmosphere.



COPPER is poured, cooled and dropped into water well in continuous cycle.

Present setup involves the melting of the cathodes in the electric furnace which is fed stacks of cathodes periodically from a preheater furnace (gas-fired). Furnace can melt 30 tph and has a holding capacity for 90 tons. Metal flows down a launder which splits two ways—to the continuous wire bar wheel and the Ajax electric holding furnace on the cake casting floor. Wire bar wheel is modern but conventional in design.

Ajax holding furnace is filled until it has sufficient copper to pour two large cakes. Then the specially designed ladle is swung into place over the two molds and the pour begun. Ladle can be tilted four ways, so that the operator in the control booth can keep the amount of metal going to each mold uniform. Charcoal is kept in the ladle to protect the molten copper.

It takes only 15 minutes to pour and pull two castings—25 ft long, 25 to 36 in. wide, 5 in. thick and weighing up to 17,000 lb. Remote devices on the holding furnace and in the control room tell the operator how much metal has been poured and how much remains in the furnace.

Cake mold is very small, only 15 in. deep. As molten metal descends through the mold it is cooled rapidly by five water sprays. No mold dressing is needed, since the metal can be kept free of the mold by oscillating the mold, using a device that can be varied up to 100 cycles per minute. Poured casting has smooth satin finish.

Cake descends into the water tank below the mold, riding down on the hydraulic ram. When casting has been completed (or when stopped due to a piece of charcoal having gone into the mold) the ladle is swung away, and the hydraulic ram pushes the casting out of the mold. Casting is hoisted to the saw floor by 10-ton crane, where it is cut into lengths as the customer prescribes.

DESIGNER NAGEL demonstrates his comminuting device, pouring solids into the feed bin for entry into air line.

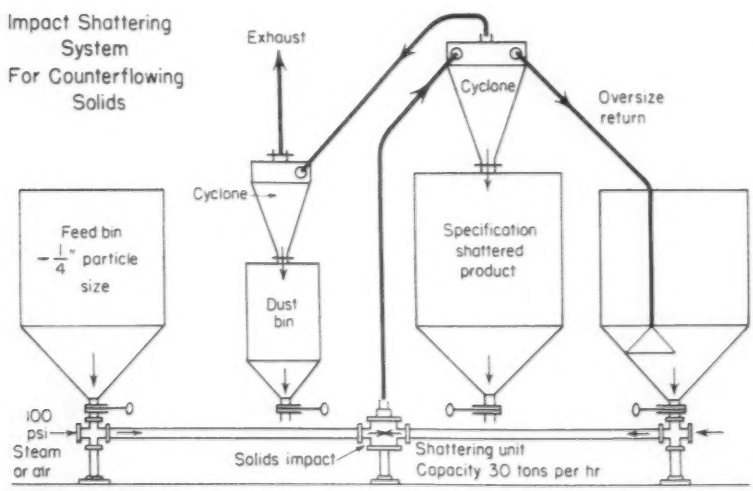
SIMPLE ARRANGEMENT of equipment emphasizes absence of moving parts, use of head-on impact of particles themselves.

Introducing—A New Method Of Impact Shattering

THE INEFFICIENCY of conventional grinding units and other comminution equipment prompted Theodore Nagel, mining engineer and industrial developer, to develop a more economical method of breaking down solids into extremely fine sizes without the aid of mechanical moving parts. He quotes Engineering Foundation 1954 report, AIME Project 104, given at the Massachusetts Institute of Technology, in support of the inefficiency of grinding techniques as follows: "Most mining and metallurgical engineers consider that fine grinding as presently practiced is only 5% effective. This inefficiency represents a large energy loss, and increasing the efficiency is a fertile field for research."

Spurred by this opportunity, Mr. Nagel initiated a technical investigation in the field of comminuting friable solids six years ago. This research resulted in the development of a unit which is substantially more economical in the reduction of minus ¼-in. particles of feed to screen, sub-screen and sub-micron powder than conventional processes. Under process patent application the technique is called "Counterflowing sonic velocity solids impact shattering."[1]

This new comminuting system requires no mechanical moving parts. The solids to be impacted are moved and accelerated with either steam or compressed air. As shown in the accompanying drawing, solids are introduced into counterflowing steam or air lines through hoppers. The solids thus entrained in the gaseous streams are accelerated and impact each other at sonic velocity. The counterflowing exhaust solids streams impacting each other generate combined action synergetic[2] force intensity equal to four times the kinetic energy of the two



ACCELERATION to sonic velocity is accomplished before solids particles impact in Nagel's shattering unit. Cyclones size the product, remove exhaust dust.

[1]Process patent No. 2,714,489 and Patent application.
[2]Synergetic means working together.

Test I—on Bituminous Coal

Gaseous medium, compressed air at 100 psig. Material, bituminous coal. Length of accelerating channels, 2.5 ft.

Particle size feed	Shattered product Per cent by weight
¼ – in.	– 200 mesh (54%)
	– 325 mesh (41%)
– 200 mesh (54%)	– 200 mesh (85%)
– 325 mesh (41%)	– 325 mesh (67%)

(Average particle size of shattered coal powder, 4.45 microns.)

Test II—on Agricultural Limestone

Gaseous medium, compressed air at 100 psig. Material, –20 mesh ground agricultural limestone. Length of accelerating channel, 5 ft.

Particle size feed	Shattered product Per cent by weight
– 10 mesh (94%)	– 200 mesh (27%)
– 20 mesh (6%)	– 325 mesh (16%)
– 200 mesh (27%)	– 200 mesh (59%)
– 325 mesh (16%)	– 325 mesh (40%)

(Average particle size of final shattered product, 13.5 microns).

solids streams exhaust as separates.

Auxiliary equipment for the 30-ton-per-hr development model shown here includes two feed bins at opposite ends of the accelerating channels; a primary cyclone at the end of the discharge line carrying shattered solids which yields three products—specified shattered product, oversize, and dust; and a secondary cyclone which removes dust from the exhaust of the system.

Performance of the impact shattering unit can be controlled over a wide range by varying the rate of feed, the pressure of the air or steam, or by varied lengths of the accelerating channels which control the momentum of the particles to be impacted. See data for 2½-ft, 5-ft, and 15-ft accelerating channels.

Application of the Unit

This unit is designed to reduce such product as pigments, paper and fabric fillers, chemical powders, disinfectants, antibiotics, etc., which are currently reduced by compartment grinding mills to about minus 20-mesh, and further reduced by secondary grinding to sub-screen (minus 325-mesh) micron powder size. It will also reduce such large-tonnage items as limestone, coal, cement, dolomite, phosphate rock and upgraded metallic ores, to minus 200-mesh. Nagel estimates that the operating cost of shattering minus 10-mesh solids without mechanically moving parts will approximate half the current compartment mill grinding cost.

The accompanying pilot plant tests demonstrate how the unit performs in breaking down coal and limestone.

If a 15-ft solids accelerating channel had been used instead of the 5-ft channel shown above, calculations indicate that the velocities of exhaust streams flowing from the 15-ft channels would be approximately twice those flowing from the 5-ft channels. Velocities and energies calculations were based on this formula:

$$E = \frac{WV^2}{2G}$$

expressed in ft lb per sec.

Counterflowing exhaust streams impacting each other generate combined action synergetic impact (solids shattering) force equal to four times the energy of the two exhaust streams and approximately four times the impact force of the counterflowing streams exhausting from 5-ft accelerating channels as shown in the above fundamental formula.

Accordingly, Nagel estimates that minus ¼-in. bituminous coal fed to 15-ft accelerating channels with 100-psig compressed air or steam should produce a shattered product with average particle size of 3 microns.

Similarly, –10-mesh limestone fed to 15-ft accelerating channels with 100-psig compressed air or steam should produce a shattered product running about 90% minus 200-mesh according to calculations.

Velocities and Energy Distribution for Test Shattering of Agricultural Limestone

Air Stream—Kinetic Energy	Energy ft lb/sec	Power
1. **Compressed air (72 kwh/hr)**	53,025	100%
2. **Energy available for accelerating solids**	24,415	46%
3. **Kinetic energy of accelerated solids**	18,800	35%
4. **Synergetic impact shattering force**	75,200	136%

Explanation of data pertaining to the four items above:

1. Input air stream, 46.1 psi at 650 ft per sec. Exhaust, 3.5 psi at 560 ft per sec velocity.

2 and 3. Energy available for accelerating solids is based on the fact that energy input less energy in exhaust equals energy available for accelerating solids. Assume: 75% of the available energy for 6 lb per sec (W) limestone feed exhausting at 450 ft per sec (V) velocity generates kinetic energy $\frac{W(V^2)}{2G}$. Solids fed to the stream are accelerated to exhaust at velocity of 450 ft per sec entrained in the air stream exhausting at the higher velocity of 560 ft per sec.

4. Counterflowing solids streams impact each other at 900 ft per sec. The combined shattering action of the counterflowing solids streams impact each other at 900 ft per sec and generate a shattering force equivalent to $\frac{W(2V^2)}{2G}$. This intensity is four times the 18,800 ft lb per sec energy of the two solids streams exhausting at velocities of 450 ft per sec and approximately 136% of the air power input, 53,025 ft lb per sec.

Why Impact Is So Powerful

The key to this novel method of comminution lies in the fact that the accelerated particles flowing in opposed streams through the accelerating channel impact head on at sonic speed and dissipate most of the combined kinetic energies of the particles in a shattering action.

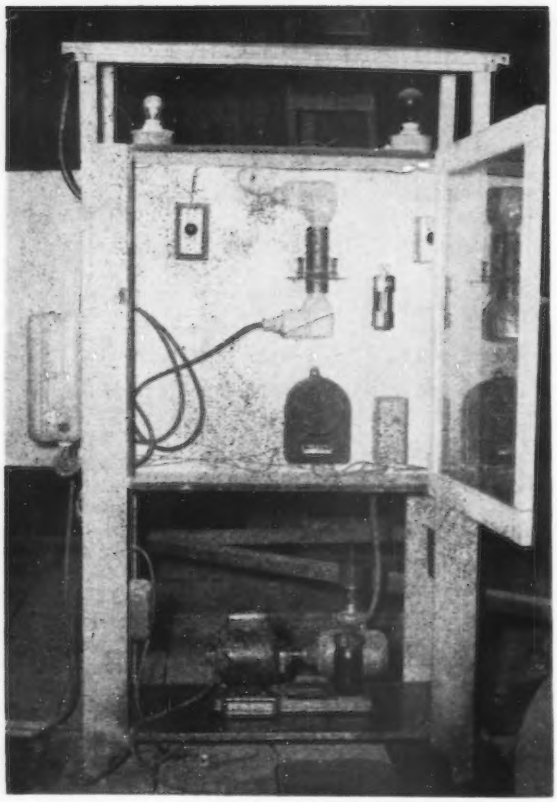
The following calculations and performance data illustrate the forces involved and how they are applied to the solids being shattered:

Minus 10-mesh ground agricultural limestone was fed to the solids-shattering device at the rate of 6 lb per sec. This was shattered to 90% minus 200-mesh particle size through 10-ft accelerating channels. The unit was serviced with 500 cfm of free air at 100 psig, which is equivalent to 800 lb per hr of steam at 100 psig. The accompanying table shows the energy distribution throughout the process, and gives stream velocities at various points in the shattering circuit.

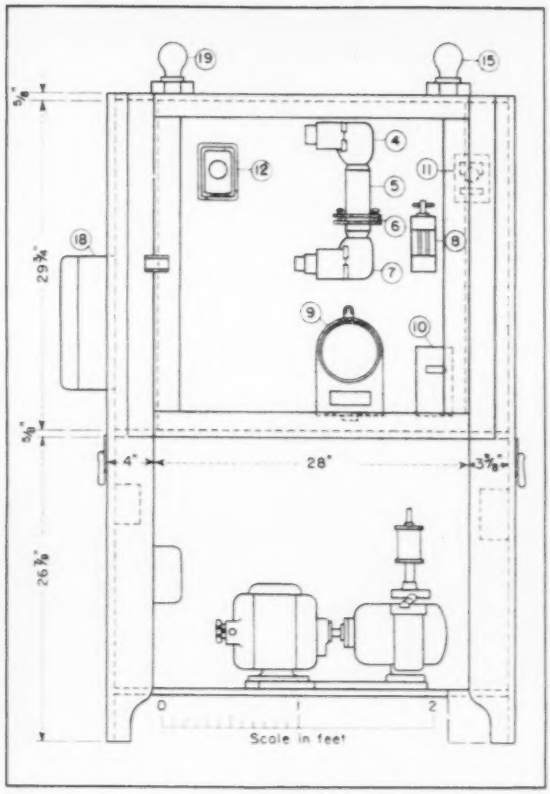
Correction

E&MJ extends its apologies to Irving Lipkowitz, author of the article on Aluminum (February 1958) for a typographical error in the section of his article under the heading "Production." The final sentence in the first paragraph of the section should read as follows:

"Capacity, however, had increased to over 1.8-million tons during 1957, compared with 1,775,500 at the end of 1956." In the original publication of the article, the latter figure was incorrectly shown as 1,839,000 tons.



ARSINE-STIBINE GAS concentration is checked continuously at the Kellogg zinc plant by a staff-designed detector.



PANEL FRONT is easily accessible for daily changing of nitrate paper. Ruby light (top right) and horn give alarm.

Bunker Hill Designs a Gas Detector

G. C. POPOFF

AT BUNKER HILL CO.'s zinc plant at Kellogg, Idaho, a staff-designed and created safety guardian performs a double function. Despite positive ventilation and plant design to avoid the probability of toxic concentrations of arsine and stibine gas, a remote danger exists. To safeguard against gas collection because of power failure or atmospheric inversions the continuous detector was evolved.

Coupled with the continuous protection which the detector provides is the secondary function of making plant employees conscious of safety measures. The detector must be serviced daily, providing a constant reminder of safe practices.

As built, the detector incorporates in its design the features required to make it a sensitive, speedy, reliable, portable, selective and easily maintained instrument. It is capable of detecting and giving warning of toxic gases from concentrations below threshold to over the threshold limit and very high concentrations. Threshold toxicity concentrations may be defined as the maximum average atmospheric concentration of contaminants to which workers may be exposed for an 8-hour working day without injury to health. Threshold limits adopted at the Sixteenth Annual Meeting of the American Conference of Governmental Industrial Hygienists, Chicago, Ill., April 24-27, 1954, are: Arsine, 0.05 ppm and stibine, 0.10 ppm. (Ppm equals parts per million expressed as volume.) For example, 1 ppm means that 1 cubic ft of toxic gas or vapor is present in 1-million cubic ft of air). The device can be operated by responsible, non-technical personnel, and because of its portability can operate almost anywhere in the plant.

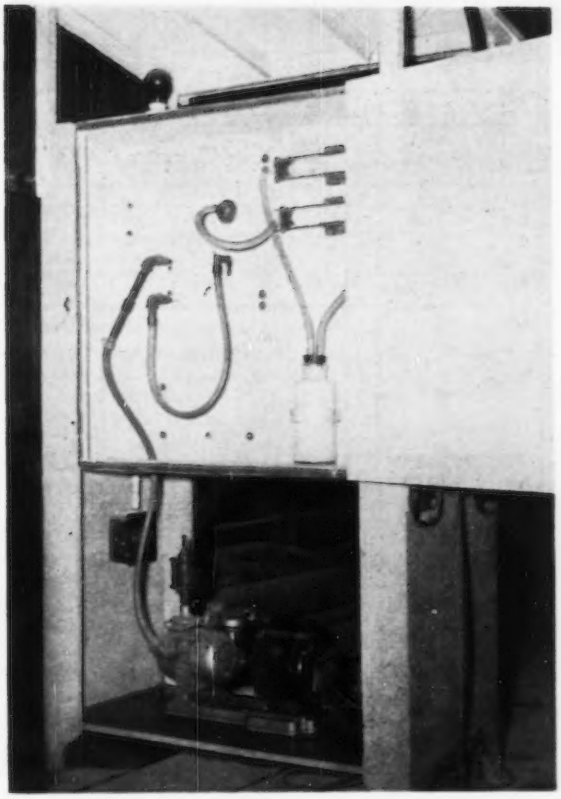
Mr. Popoff is chief research metallurgist at the Bunker Hill Co. zinc plant at Kellogg, Idaho.

Operating Principle

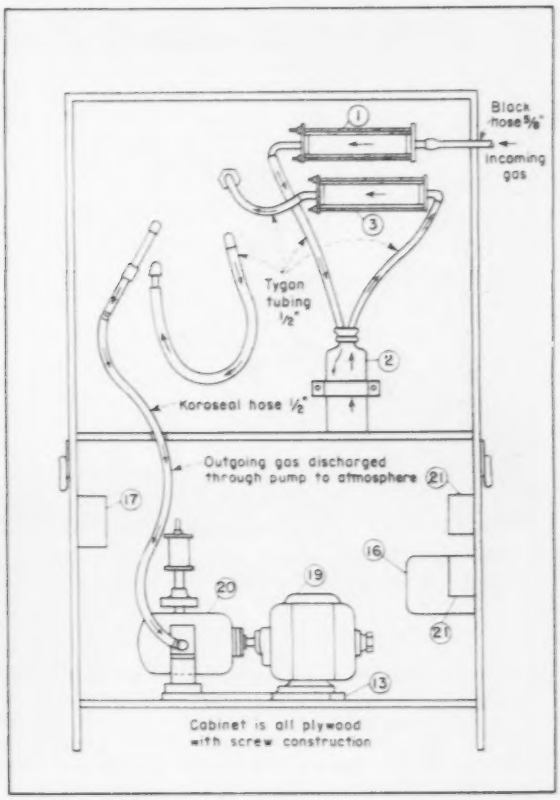
The detector unit operates on the principle of darkening or blackening a white filter paper impregnated with silver nitrate when the paper is subjected to a stream of air containing arsine or stibine or both. Rate of darkening and the intensity of the blackening (which produces a so-called "spot") are functions of the concentration of AsH_3 or SbH_3, or both, in the gas stream. The heart of the warning device is a photoelectric cell ensemble equipped with a beam of light which is transmitted through the silver nitrate paper. When sufficient discoloration (darkening) of the paper occurs through chemical reaction between silver nitrate and arsine or stibine, or both, the light beam is interrupted by the "spot" and the photoelectric cell activates an electrical circuit, giving both visible and audible warning. The reactions on impregnated paper are:

$$3AgNO_3 + SbH_3 = Ag_3Sb + 3HNO_3$$
$$3AgNO_3 + AsH_3 = Ag_3As + 3HNO_3$$

Small amounts of arsine and stibine gases will cause the detection paper to discolor, the intensity being a function of the exposure. For example, a



PANEL BACK shows scrubbers and tubing. Photoelectric cell keeps constant watch on shade of the test papers.


Black hose 5/8"
Incoming gas
Tygon tubing 1/2"
Koroseal hose 1/2"
Outgoing gas discharged through pump to atmosphere
Cabinet is all plywood with screw construction

DESIGN is simple, highly efficient. Carrying handles provide portability. See legend below for key components.

LEGEND

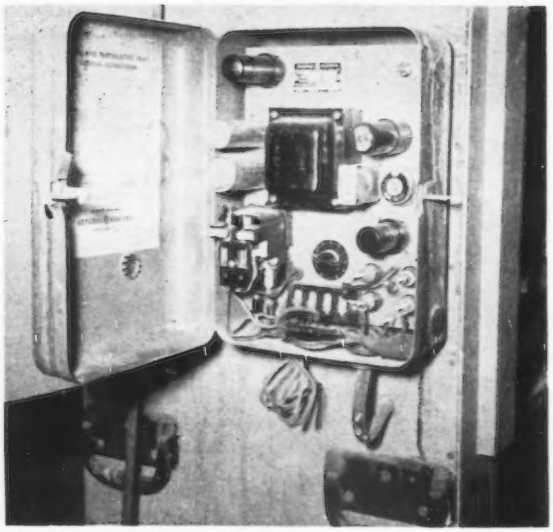
1. Dry scrubber (cotton)
2. Wet scrubber—lead acetate and glass wool in a wide mouth bottle. (Flint glass for general use—1 qt, No. 2)
3. Dry scrubber—lead acetate and gun cotton
4. Light source (G.E. No. CR 7505-C 202-G-1, Tube No. 1323)
5. Paper holder
6. Paper
7. Phototube holder (G.E. No. 7505-P 202-G-2, Tube No. G.E. GL 5581)
8. Flowrator (Fischer & Porter, Serial No. T-6-149071, Glass No. T-6-1490/1. Max., 0.2 cfm; Min., 0.04 cfm)
9. Time switch (G.E. No. 3TSA16, Type AG-60. Time cycle: 60 sec, 10 amp, 115 v, 60 cycle)
10. Relay (G.E. No. CR2790-E101A2, 115 v, 60 cycle)
11. Push button (G.E. No. CR2940-1A1)
12. Indicator light (G.E. No. CR2943)
13. Pump and motor base
14. "Ruby" alarm light
15. White "power on" light
16. Voltage stabilizer (G.E. No. 69G851, kva 0.10, Serial No. YH. Line volts 95 to 130, output 115 v. Outline K-5808590UT. Pat. No. 2143745)
17. Transformer (G.E. No. 9TY51A1, Cycle 50/60, kva 0.0185, Serial BH. Volts 115 to 230 PRI. 5.25/4.84 sec. Instructions K5003912. Light source is connected to red-black and black on transformer light source
18. Photoelectric relay (G.E. CR-7505-N110-G-14, Volts 115 to 230, 45 w, Cycle 50/60. Diagram P-914360-B. Instructions GEH-1344. Tubes 125L6 GT; 1-2526; 1-65J7. Control relay CR-2790-E100-N21. Contacts: 10 amp, 145 v dc. Located in photo relay
19. G.E. ¼-hp motor (No. 5KC45-AB1-400C. 1725 rpm, 116 v, 4.0 amp, 60 cycle)
20. Pump (Cast Manufacturing Corp. No. 0465, Serial No. M-14967)
21. Four junction boxes (1. toggle switch; 2. covered; 3. fuse; 4. duplex outlet. 10 amp, 250 v, 15 amp, 125 v)

small concentration of AsH_3 or SbH_3 in the air being sampled will require a large flow of air through the machine before sufficient "spot" is generated; conversely, a large concentration will generate a heavy "spot" in a very short time. The photoelectric cell could be made to activate with very low absolute amounts of arsine, as low as 0.003 mg, but this would result in false alarms because of extreme sensitivity.

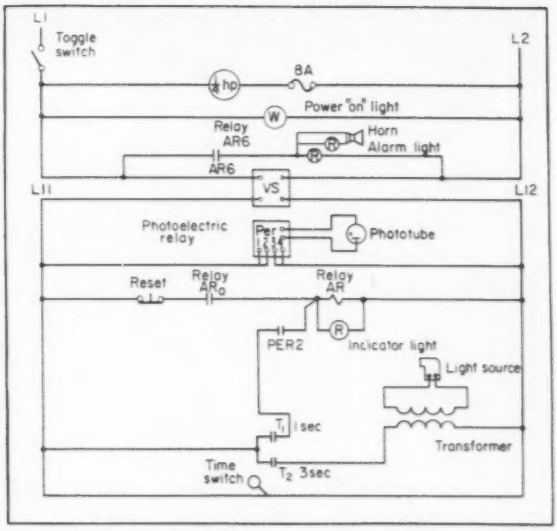
The area to be tested is covered with suitable pick-up points, from which the gas is pulled by negative pressure through plastic tubing to and through the detector.

Construction

Construction of units making up the detector and their functions in the general assembly are shown in the accompanying illustrations. Air to be sampled is pulled into the machine by a mechanical vacuum pump through a train of equipment consisting of: (1) lengths of polyethylene pipe from sampling points to the chemical trains, "Tygon" tubing for the train connections, and "Koroseal" hose from the flowrator to the pump; (2) dry cotton scrubber to filter incoming air; (3) wet lead acetate scrubber of glass wool to eliminate hydrogen sulphide gas, if present; (4) dry scrubber of cotton treated with lead acetate as another scrubber for H_2S; (5) paper holder situated between the light source and photoelectric tube. (This chamber-like unit in which the air to be sampled passes through a silver nitrate paper



GENERAL ELECTRIC photoelectric relay unit is attached to side of portable detector. Strict safety levels are kept.



ELEMENTARY DIAGRAM of complete system shows provision for warning system, phototube operation, timers.

held tightly between two gaskets is equipped with two plain lenses to permit a beam from the light source to pass through the chamber.); (6) flowrator to regulate admission of air to be sampled at a definite rate; (7) motor-driven vacuum pump to pull air through the train and to discharge outgoing air to the atmosphere; (8) electrical equipment necessary for starting the machine and distribution of power through various circuits.

Detection Factors

Detection of AsH_3 or SbH_3, or both, takes place in the paper holder chamber on contact of gas with the silver-nitrate-treated paper. The principle of detection is a colorimetric effect of either of the two gases, or both, on the silver nitrate paper. The intensity of coloration of 1½-in. diameter spot formed on the paper is the deciding factor in detection.

The warning system, which goes into action the moment the intensity or darkening of the spot reaches a predetermined value, comprises a white "power on" light to indicate working order of the machine; voltage stabilizer for photoelectric relay system and light source circuit; phototube activated variable setting photo relay; phototube holder with phototube sensitive to the change of intensity in the spot coloration caused by the presence of either AsH_3, SbH_3, or both; transformer for the light source to step down voltage from 110 to 5.25 v; automatic time switch; light source generating a beam of light, which, when interrupted by a change in intensity of paper coloration causes the phototube to activate the warning system; alarm system; and reset push button which is manually pushed to de-energize the alarm relay.

The photoelectric tube mentioned is equipped with a light shield which has the effect of permitting insufficient light to impinge on the photo-active element of the tube. This shield must first be removed so that the phototube may receive enough light to activate the relay.

The automatic time switch permits the light source to scan silver nitrate paper only 3 sec out of every 60 to prolong the life of the paper, which otherwise will darken sooner under exposure to continuous light. It also limits the phototube scanning the paper only 1 sec out of every 60.

The alarm system consists of colored lights installed in the office of the department, on top of the detector, and indicator light on the panel; and signal horn.

Operation

With periodic maintenance service insuring smooth operation of the detector, the operator of the department in which the unit is situated must see that: (1) the detector is operating; (2) the air to be sampled is admitted to the detector at 0.1 cfm; (3) the papers are changed at least once in 24 hours; and (4) that proper lubrication of pump and motor is maintained.

When the device gives warning, all workmen must evacuate the area. The supervisor, wearing a self-contained oxygen breathing apparatus, must determine whether the alarm is true or false. If the silver nitrate paper is not discolored it is probable that the alarm is false.

In the event of a false alarm, or one considered to be indeterminate, the operator will reset the relays, insert new paper, then call the instrument department for inspection, adjustment, and/or repairs to the detector. If the time lapse on the second paper is more than 13 minutes, area is considered safe for workers. If the alarm persists, then the unit is replaced.

Reset Procedure

In the event of a true alarm, the supervisor should replace the test paper, reset the detector, and wait for about 13 min. Should the warning be repeated in less than 13 min. a check of the ventilating system, opening of windows, and any other tasks helpful to bring about rapid elimination of gases in the area is immediately indicated. After the cause of arsine or stibine gas generation has been eliminated, the supervisor should continue to attend the detector until it fails to give an alarm.

At the zinc plant, the detector is set at arsine threshold limit of 12.7 min. for 0.05 ppm AsH_3 at 0.1 cfm air flow for one sampling point to attain maximum safety. However, it should be pointed out that some degree of tolerance to the precision of operation must be granted due to sensitivity of electrical and photoelectrical equipment, degree of maintenance work done on detector, variation in formation of spots on silver nitrate paper, a possible delay in the response of the photoelectric circuit due to timer device permitting phototube scanning

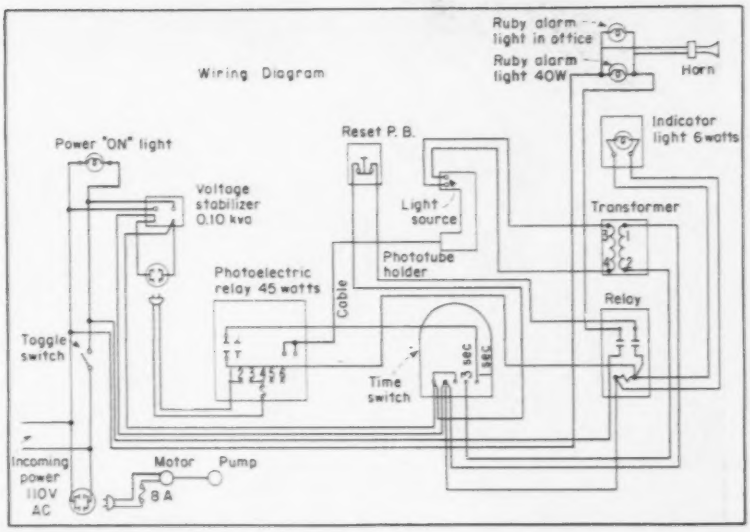
of the paper only 1 sec out of every 60, and lower sensitivity, if more than one sampling point is used for the same detector.

Preparation of $AgNO_3$ Paper

An E&D, No. 613 filter paper of smooth and even texture is used. Solution used for treating paper consists of 10 grs of $AgNO_3$ and 12 drops of HNO_3 per liter of solution in distilled water. The paper is soaked in this solution and dried. It should not be used until about three days old. All preparations should take place in the dark room. The paper is cut into 2x2-in. pieces for spot 1½ in. in diameter. The papers are stored in dark brown bottles and should not be kept more than three weeks.

The development of the Bunker Hill arsine and stibine detector was the result of many years of continuous research by the metallurgical staff of the electrolytic zinc plant. It was a genuine "team" effort under the guidance and council of W. G. Woolf, then plant manager and now vice president of Kellogg operations, and A. Y. Bethune, manager of metallurgy.

The early work of successfully applying the detection principle under operating conditions in the plant was carried out by A. Y. Bethune. The latter work and the development of the device in its present form was accomplished by Walter Schmittroth, zinc plant superintendent, S. H. Keller, assistant superintendent, Douglas Baker, departmental superintendent, Leo Baumeister, chief chemist, Thomas Tapper, mechanical superintendent, smelter, and the author.



WIRING SYSTEM is relatively simple, provides for extra alarm light in plant office. Detector runs check on gas concentration one second each minute.

LETTERS

Letter to the Editor

May I compliment you on the fine job that your editor did on the meeting sponsored by the Uranium Institute of America and the U. S. Chamber of Commerce at Denver, December 16 and 17, 1957, appearing in your January issue.

There are, however, two points that could bear further comment:

1. The report indicates that we pay less for foreign uranium concentrates than for domestic concentrates. Actually until 1957 this was true but today our average domestic price is less than our average foreign price and will continue to be less in the future.

2. I am quoted as saying that if open competition develops the low-grade producer should go to the wall first. This actually was given in my talk as a quotation from an address given by Dr. van Rhijn, Minister of Mines of the Union of South Africa. While making this statement, however, Dr. van Rhijn went on to say that because uranium is a by-product of gold in the Union, many of the mines in South Africa could be "fiercely competitive in their uranium sales policy." I am inclined to agree with Dr. van Rhijn even though the grade of the South African ores is extremely low.

John T. Sherman
Assistant Director for
Domestic Procurement
Division of Raw Materials, AEC

It (the February 1958 Annual Survey and Outlook issue) is an excellent reference volume, and I regret the necessity for calling attention to a typographical error which might cause the vermiculite industry some embarrassment.

On page 156 in the lower right-hand column, the following statement is made, ". . . about 23,000 tons of vermiculite were used in 1957."

This amount is correctly stated in the article under, Vermiculite, in the right-hand column, second paragraph, where it is stated, "It is estimated that approximately 230,000 tons of vermiculite were consumed in 1957."

William S. Steele
President
American Vermiculite Corp.

In your February 1958 issue the article, "E&MJ Surveys Mine, Mill, Smelter and Refinery Developments in 1957" contains an error that we would like to call to your attention. The article says on page 171:

"Northern Rhodesia. Chambishi and Baluba mines will be in production by 1960."

Although development of Chambishi and the Baluba orebodies has been given considerable attention, neither is being developed as a mine at this time. As mines of the size involved in these two cases would take a number of years to complete, neither would be in production by 1960 unless development were now under way. The reasons for postponing development of the two mines are explained by Sir Ronald Prain in his statement accompanying the Annual Report for 1957 of Rhodesian Selection Trust (Oct. 18, 1957).

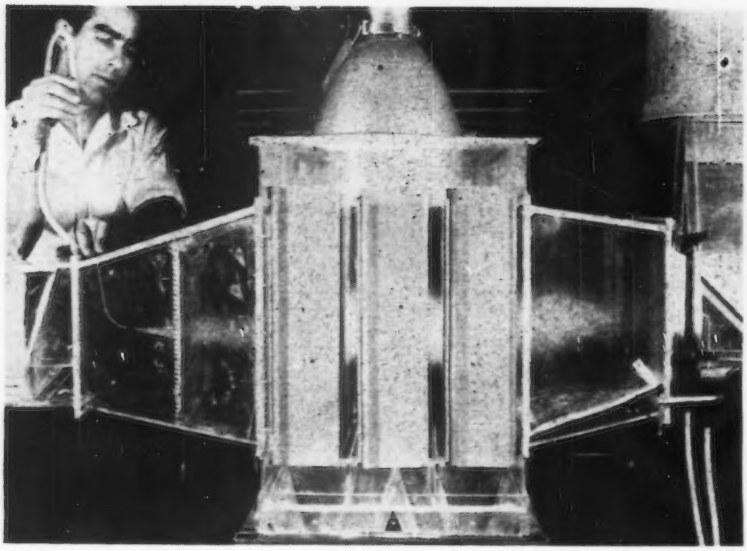
Although this error did not enter the estimate of copper mine capacity on page 115 of the same issue, the error might nevertheless offer some readers an exaggerated view of new copper and cobalt capacity in the next few years, and hence might well deserve a correction.

Thomas D. Kaufman
American Metal Climax, Inc.
New York, N.Y.

We note in the February issue of the *Engineering and Mining Journal* on pp 154-5 a brief review of vanadium. In conection with a statement made in this report, we would like to point out that this corporation has produced pure vanadium metal continuously since 1929. Originally this material was supplied largely in response to needs of research and small scale operations. For the past several years we have supplied a considerable volume of high-purity vanadium metal to satisfy the needs of a substantially greater market.

The above information is offered merely to put in proper perspective certain statements made in your article.

C. M. Cosman
Metallurgical Engineer
Vanadium Corporation of America



USING smoke, dust and string, Research-Cottrell engineers study gas flow patterns in scale models. Deflectors, vanes and poles are inserted to correct gas flows.

TAKING velocity traverses across the precipitator plates shows exact flow.

How Model Studies Aid Dust Collector Design

POOR COLLECTING EFFICIENCY, unnecessary pressure drops and dirty effluent can be eliminated or reduced if a scale model study can be made before the system is installed.

High construction costs, high operating costs, corrosion losses and the need to install an oversize collector can also be done away with by model studies. Even existing installations can be improved.

Research-Cottrell, Inc., Bound Brook, N. J., says that there are many other advantages to making model studies; an idea born of necessity in their research department. Here are a few case histories.

Case History No. 1. Power plant Cottrell installation had such a poor collecting efficiency that the engineers didn't even like to mention how low it was. Model study idea was suggested and tried. Study showed that the simple installation of a deflecting vane at one point in the flue system would double the collecting efficiency. Turbulence, the bug-bear of dust collecting, was corrected by the vane, and the idea of using models to study dust collecting systems was established.

Case History No. 2. Model study of the flue design of another power station, using smoke, string and ground cork as visual aids, showed that gas flow within a system does not always conform to conventional thinking. New flues were designed to fit the actual gas flow within the system. Improved design reduced construction cost, greatly reduced turbulence and improved dust collecting efficiency over what would have occurred had the system originally designed been installed. And it was added that most systems are just installed, not designed as they should be.

Case History No. 3. Asked to fit Cottrells into an existing aluminum pot line, R-C engineers insisted on a model study which arrived at seven different flue designs that would provide top efficiency to 43 electrostatic collectors installed in the plant.

Case History No. 4. Model studies of flue design to a mechanical collector (multiple cyclones) for a power plant job showed that gas flow within a flue can be corrected and spread uniformly across the face of the collector by installing poles and vanes at strategic places within the flue. Uniform gas velocity profile to the face of a collector and through the collector means that the collector can do its most efficient work.

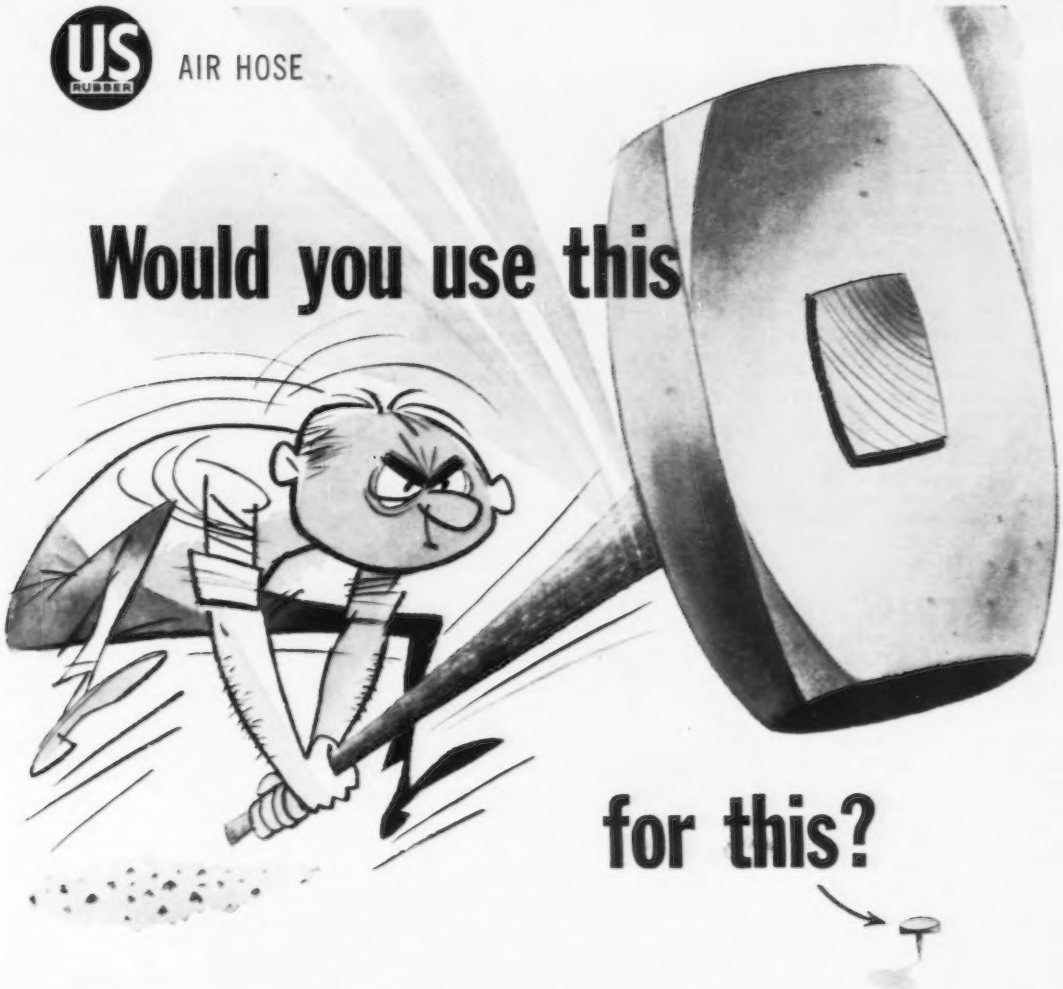
Case History No. 5. On a steel mill project, model study found that specially designed perforated steel plates placed at strategic points across the face of the flue would equalize the gas flow profile to the collector—again uniform gas flow meant improved collection.

Case History No. 6. Recent model study for a public utility resulted in flue designs that cut pressure drop through the system by 40%—a very real saving, since the utility industry considers each inch of pressure loss in a boiler system to be worth from $40- to $80,000 in capital cost (for fan power). In addition, collector performance was improved.

Case History No. 7. Here is an example on what can happen within a system based on theory and not on fact. Research-Cottrell installed an electrostatic collector based on gas flow velocities furnished by the purchaser. It failed to function at contract guaranteed efficiency and the purchaser complained to R-C. On a plant shutdown, R-C engineers climbed into the flue and found that local gas velocities just in front of the collector were so high that refractory bricks had been pulled from the flue lining and stacked up in front of the electrostatic collector! Velocities are not uniform over a collector profile, no matter what the design engineer may suggest. Model studies can make them uniform.

US RUBBER AIR HOSE

Would you use this



for this?

Then why pay extra for heavyweight, muscle-bound air hose, when U. S. Rubber Air Hose is easier to handle, more flexible, and withstands higher working pressures... at lower end cost.

When you're on a tight budget and a tight schedule, there's no sense in throwing dollars away buying overweight, hard-to-handle air hose. Such hose—with excessive, unnecessary plies—is out of date, will slow you down, and leave you out of pocket.

Now, thanks to "U. S." engineering, you get the optimum balance in air hose—easier to handle *and* at the same time tougher and less expensive. What's more, U.S. Air Hose handles higher working pressures than the conventional air hose you might be using.

Every hose in the complete "U.S." line is designed to give maximum service, even under unreasonable demands. Take advantage of the skill and long experience of "U. S." Hose technicians, plus "U. S." research and production facilities. Get U.S. Air Hose at your local authorized "U.S." Hose Distributor, or write us at Rockefeller Center, New York 20, New York. In Canada: Dominion Rubber Co., Ltd.

US RUBBER Mechanical Goods Division

United States Rubber

See things you never saw before. Visit U. S. Rubber's New Exhibit Hall, Rockefeller Center, N.Y.

PERSONALS

Howard S. McCray has been elected chairman of the board of directors and chief executive officer of the Texas-Zinc Minerals Corp. **A. L. Hayes** has been elected president. Mr. McCray, who joined the Texas Co. in 1926, has served as manager of the operations division of the company's refining department, and was manager of Texaco's Purchasing department since 1955. Mr. Hayes, with the New Jersey Zinc Co. since 1927 when he took a degree in mining engineering from the Colorado School of Mines, has been manager of the Texas-Zinc Minerals Corp. (jointly owned by Texas Co. and the New Jersey Zinc Co.) since July 1956.

McCray

Steven E. Erickson, director of beneficiation for M. A. Hanna Co., was elected chairman at a meeting of AIME's Minnesota section, succeeding **John D. Boentje,** vice president and general manager of Pacific Isle Mining Co.

George Hallada, mining engineer at Embarrass mine of Pickands, Mather & Co., has been transferred to Erie Mining Co.'s engineering department. **Paul Willard,** operating assistant at Tioga No. 2 mine, has been transferred to Erie Mining Co.'s supervisory force, as has **Tom Erspamer,** operating assistant at Mahoning mine.

Dr. A. K. Schellinger, formerly professor of metallurgy at Stanford University, is now with M. A. Hanna Co. in Cleveland as a metallurgical engineer.

W. C. Lapple, of Kansas City, is a new member of Oliver Mining Division's research laboratory in Duluth. **Robert L. Kampen** has been promoted to plant foreman at Sherman mine crushing and screening plant.

Franc R. Joubin, known for his contribution to the discovery of uranium deposits in the Blind River-Algoma region of Ontario, has been appointed to serve on the National Advisory Committee on Research in the Geological Sciences.

Paul M. Elliott has been appointed superintendent of the Sullivan concentrator of Consolidated Mining & Smelting Co. of Canada Ltd. He succeeds **H. W. Poole,** who retired Jan. 30.

Van H. Smith has joined the firm of Simard, Knight & Associates as mineral dressing consultant. He retired recently as manager of North American Cyanamid.

A. J. Wood has been appointed a director of Modderfontein Gold Mines. **N. W. S. Lewin** has resigned from the board.

Rene J. S. Mayer has joined the board of the Rio Tinto Co. Ltd.

Murl H. Gidel, assistant chief geologist for Anaconda Co., retired Jan. 1.

Fred D. Hoover has been named superintendent of the Gilbert (Minn.) iron mine, by Oliver Iron Mining Division.

G. G. Potier has been appointed director of Consolidated Gold Fields of S.A. Ltd. and of New Consolidated Gold Fields Ltd.

L. G. White resigned as manager of mines and exploration for Transcontinental Resources Ltd. to join the Vancouver engineering staff of the Karl J. Springer interests.

Robert J. Beggs has been appointed manager of Kerr-Addison Gold Mines, succeeding the late John L. Ramsell.

Donald B. Muckler has been appointed assistant superintendent at Oliver Iron Mining Co.'s Rouchleau (Va.) mine, replacing L. E. McKenzie who has retired.

Wallace G. Woolf was named "Inland Empire Engineer of the Year" by the Washington Society of Professional Engineers. Mr. Woolf, vice president in charge of Kellogg operations for the Bunker Hill Co., was one of five candidates competing for the honor and represented the Columbia section of the AIME. The award was made in Spokane, Wash., on Feb. 21 and accepted for Woolf, who was attending the annual AIME convention in New York City, by Norman J. Sather, Bunker Hill superintendent of concentration. An outstanding achievement of Woolf's career was research work done at Bunker Hill leading to development of "four-nine" zinc (99.99 plus percent pure).

Woolf

Henry Beaufort Somerset has been elected president of the Australian Institute of Mining and Metallurgy for 1958.

Roger Jeanty has been appointed executive assistant to the president of Rio Tinto Mining Co. of Canada Ltd. He is also a director of newly formed Rio Tinto-Dow Ltd., and continues as president of Pyrites Co., Wilmington, Del.

A. G. Davies has been appointed a director of the Zinc Corporation Ltd.

D. J. Farquharson has been appointed a director of West Vlakfontein Gold Mining Co.

J. Allan Perham has been appointed resident director of Atlas Copco companies in the U.S.

Charles Allen Jr., chairman of the board of Campbell Chibougamau Mines Ltd., Toronto, has resigned from the board but will continue as an adviser.

Norman A. Moberg, mining engineer, Duluth, has been appointed director of mineral development for U.S. Steel's Oliver Iron Mining Division. He has been manager of Oliver's mining engineering department for the last five years, and is active in the Minn. section, AIME.

David D. Baker, director of AEC's mining division of the Grand Junction Operations Office, has been named head of the new concentrates procurement division. He succeeds **Arthur E. Granger,** who has returned to Salt Lake City as head of AEC's exploration branch.

Dale I. Hayes, for many years an official of American Zinc, Lead & Smelting Co., has resigned to accept a position as vice president and general manager of Hidden Splendor Mining Co., Salt Lake City. **Otto D. Rohlfs Jr.** will continue with Atlas Corp., of which Hidden Splendor is a subsidiary, as consulting engineer.

Jean-Paul Drolet, formerly with Quebec Department of Mines, has been appointed assistant to the president of Quebec Cartier Mining Co.

James D. Moore has been named production manager of Vitro Uranium Co. mill at Salt Lake City, Utah. Formerly with Sinclair Refining Co., Moore joined Vitro in 1951 as a chemical engineer.

Walter F. Munford has become executive vice president-engineering and research of United States Steel Corp.

Dr. W. Martin Fassell Jr., who continues as director of research for Howe Sound Co., was elected vice president of the firm's subsidiary, Calera Mining Co. A native Utahn, Dr. Fassell was at one time research assistant for the hydrometallurgy laboratory of USBM at Salt Lake City. He effected replacement of the hydrogen reduction process at Calera's Garfield refinery with the "electro-wining" process of cobalt metal reduction.

Don H. Baker Jr., supervisory metallurgist at the U.S. Bureau of Mines' Electrometallurgical Experiment Station, Boulder City, Nev., received one of ten annual Arthur S. Flemming awards, sponsored by the Junior Chamber of Commerce of Washington, D.C., and the American Security & Trust Co. and given to outstanding young men in the Federal Government. Named for the former Director of the ODM, the award, bestowed on Feb. 20, was given to Baker for his development of a fused-salt electrorefining process that has made it possible to produce titanium metal in "super-pure" form and promises to be applicable to other metals such as zirconium, hafnium, chromium and vanadium.

Baker

A Bronze yoke bushing nut
B Handy grip iron wheel
C Bronze yoke bushing
D Iron yoke cap with zerk fitting for lubricating bushing
E Steel yoke cap bolts and nuts
F TYPE 316 STAINLESS STEEL spindle
G NI-RESIST CAST IRON, TYPE 2, yoke
H Bronze eye bolt nuts
I Malleable iron gland flange
J Steel gland eye bolts
K Steel gland lug bolts and nuts
L TYPE 316 STAINLESS STEEL gland
M Teflon impregnated asbestos packing
N TYPE 316 STAINLESS STEEL bonnet bushing
O NI-RESIST CAST IRON, TYPE 2, bonnet
P Steel bonnet bolts and nuts
Q TYPE 316 STAINLESS STEEL spindle ring
R Asbestos gasket
S TYPE 316 STAINLESS STEEL wedge pin
T NI-RESIST CAST IRON, TYPE 2, through-port body
U TYPE 316 STAINLESS STEEL solid I-beam wedge
V TYPE 316 STAINLESS STEEL seat rings

Wherever valves are attacked by acids, salt and alkaline solutions, sea water, brine or other corrosive fluids, vapors or gases, "Jenkins Ni-Resist Gate Valves" are *fighting* words.

In a wide range of corrosive and erosive services common to the chemical, food, plastics, marine, petroleum, and pulp and paper industries, these valves have shown a remarkable ability to withstand corrosion and cut valve costs.

The secret of their long, trouble-free service is the combination of Ni-Resist type 2 cast iron and type 316 stainless steel trim, plus Jenkins *extra value* construction throughout. No other gate valves offer this combination for fighting corrosion.

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PERSONALS *(Continued)*

Darrell Gardner was appointed general manager of Magma Copper Co., effective Feb. 28, in charge of the Superior, Ariz. operations.

Liang

Dr. Ta Liang, widely known in the field of air photo interpretation, soil mechanics and foundation engineering, has joined Aero Service Corp., Philadelphia as a consultant. Dr. Liang is a professor at Cornell University.

Brown

Leroy T. Brown is in Tinaquillo, Cojedes, Venezuela where he is a general manager and a director of Amveco, C.A., asbestos mining and milling company, division of World Commerce Corp. S.A., New York.

Albert R. Cook, formerly sales development engineer for Northern Aluminum Co., Banbury, England, has been appointed market development engineer for the American Zinc Institute, Inc.

H. M. Pickering, who recently retired as mine superintendent for Oliver Iron Mining Division, has opened a mining consulting office in Hibbing, Minn.

John D. Barrington has been appointed president and managing director of McIntyre Porcupine Mines, Ltd. He is presently president and managing director of Ventures Ltd., and formerly held the same position with Polymer Corp. Ltd., to which he was appointed by the Canadian government in 1951. Also appointed were **M. L. Urquhart** as vice president-operations and **S. M. Wedd** as a director.

R. D. Parker, vice president of Inco's Canadian operations, has been appointed president of the Ontario Mining Association to complete unexpired term of the late J. L. Ramsell; **M. L. Urquhart,** of McIntyre Porcupine, and immediate past president of the association, is vice president for the same term.

G. E. Atwood, resident manager of Duval Sulphur & Potash Co.'s copper division has been elected a vice president.

J. A. Kelley has been elected president of Zonolite Co., Chicago, succeeding **J. B. Myers,** who resigned, but who will continue as a consultant.

R. F. Goodwin, chairman of executive committee of Southern Peru Copper Corp., has been elected president of the Mining and Metallurgical Society of America. The former Asarco vice president in charge of mining also serves as president of the Peruvian-American Society of America. On Jan. 29 Mr. Goodwin presented MMSA's Gold Medal to **Col. Donald M. Liddell,** the first metallurgist to produce selenium and tellurium on a tonnage basis.

OBITUARIES

Edward H. Emerson, 80, retired mining engineer, died Feb. 26 in New Rochelle, N.Y. He was a partner in Emerson & Hill, New York mining consultants, and formerly president of Cuba Copper Co. and the Phoenix Mines in Cuba, & consulting engineer to General Chemical Co.

Edward J. Fearing, 64, former general superintendent for Pickands Mather & Co., Hibbing, died Feb. 18 in Minneapolis. Appointed general superintendent in 1950, he retired in 1955 because of poor health.

Thomas H. Moore, 31, geologist of Quebec Cartier Mining Co., Montreal, died Feb. 27. He was a member of CIMM and the Geological Society of America.

Warren A. Davidson, 73, died in the Bralorne, B.C., hospital Jan. 17 after a long illness. During the gold boom of the depression days he brought the Minto property from raw prospect to producing mine; later he became owner of the Minto Trading & Development Co.

John H. Hearding Sr., 93, pioneer mining man and retired assistant general manager of the Oliver Iron Mining Division of the U.S. Steel Co., died Feb. 28 in Duluth. Mr. Hearding went to the Gogebic range in 1888 as a time-keeper. In 1894, as superintendent for Lake Superior Consolidated Mining Co., he began operations of stripping Adams mine which heralded open pit mining in Eveleth district. Mine was acquired by Oliver Iron, and from 1904-09 he served as general superintendent of Oliver's Eveleth district. In 1909, he was appointed assistant general manager of Oliver Iron Mining Co. (afterward Oliver Iron Mining Division) and moved to Duluth. He retired in 1932.

Arthur Ernest Northey, 82, died Oct. 28. He was a member of the Institution of Mining Engineers and the Institution of Mining and Metallurgy, and was manager of tin-tungsten properties in Spain during WWI.

John R. Skinner, chief at New Jersey Zinc Co.'s new mine in Treadway, Tenn., died Mar. 1 in a mine accident.

John Goodall Dickenson, 74, well known mining engineer and former manager of the O'Brien mine at Cobalt, died recently at his home in Toronto. In 1940 Mr. Dickenson started a consulting engineer practice in Toronto and assisted in development of the New Dickenson Mines in the Red Lake district. He was a member of the CIMM, and Ontario Professional Engineers Association.

William L. Creden, 88, retired mining engineer, died Feb. 15 in Butte. At one time engineer and superintendent of mines for F. Augustus Heinze, he later established consulting engineering offices in Butte. He was chairman of Montana Alumni Association of MIT, member of AIME, Montana Society of Engineers, Mining Association of Montana, and president of Creden Mines Corp.

George W. Raynor, 74, well known Canadian mining and civil engineer, died in Toronto in early 1958. As prospector in the booming cobalt days, he staked claims for Coniagas Mines and was again in the forefront in the Little Long Lac area gold boom of the mid-30's.

Gerald Stoker, 57, long-time Mullan (Idaho) resident and former employee of Asarco's Morning mine, died in Spokane Jan. 3.

An Appreciation

James Latimer Bruce, 77, vice president, consulting engineer and director of Cyprus Mines Corp., and AIME Legion of Honor member, died suddenly Feb. 6. He is survived by his widow Leah Hills Bruce, four children, 11 grandchildren and two sisters.

Born in Dublin, Ire., his early schooling was obtained largely at home near Haliburton, Ont. and then in school at Woodstock, Ont., until at 13 he joined his father in Denver. He entered Colorado School of Mines in 1896 and was graduated in 1901 after having taken a year's leave between sophomore and junior years to earn sufficient to enable completion of his course.

Until 1904 he worked for various firms at Cripple Creek as surveyor, assayer, draftsman and engineer. In 1904 he went to southeast Missouri to work for Federal Lead Co., continuing as surveyor, chief engineer and general mine foreman until 1907, when he went to Joplin for various companies and finally with Continental Zinc Co. as manager.

In 1913 he became associated with Butte & Superior Co. which D. C. Jackling was developing.

In September 1919, Bruce became manager of Davis-Daly Copper Co. at Butte; from 1924-25 he was consulting engineer in Salt Lake City, after which he began his long association with Cyprus Mines Corp.—to 1939 as manager and resident director in Cyprus and thereafter as vice president, consulting engineer and director in the U.S. and was closely connected with the affairs of Pima Mining Co. and Marcona Mining Co.

Mr. Bruce was a member of American Mining Congress and of the Engineers Club of Los Angeles. During World War II he served as consulting engineer for the WPB. Prior to Pearl Harbor he recommended to OPA the Premium Price Plan which was subsequently used for stimulating zinc production.

In 1949 at the 75th Anniversary Convocation of Colorado School of Mines, Mr. Bruce was awarded the Distinguished Achievement Medal.

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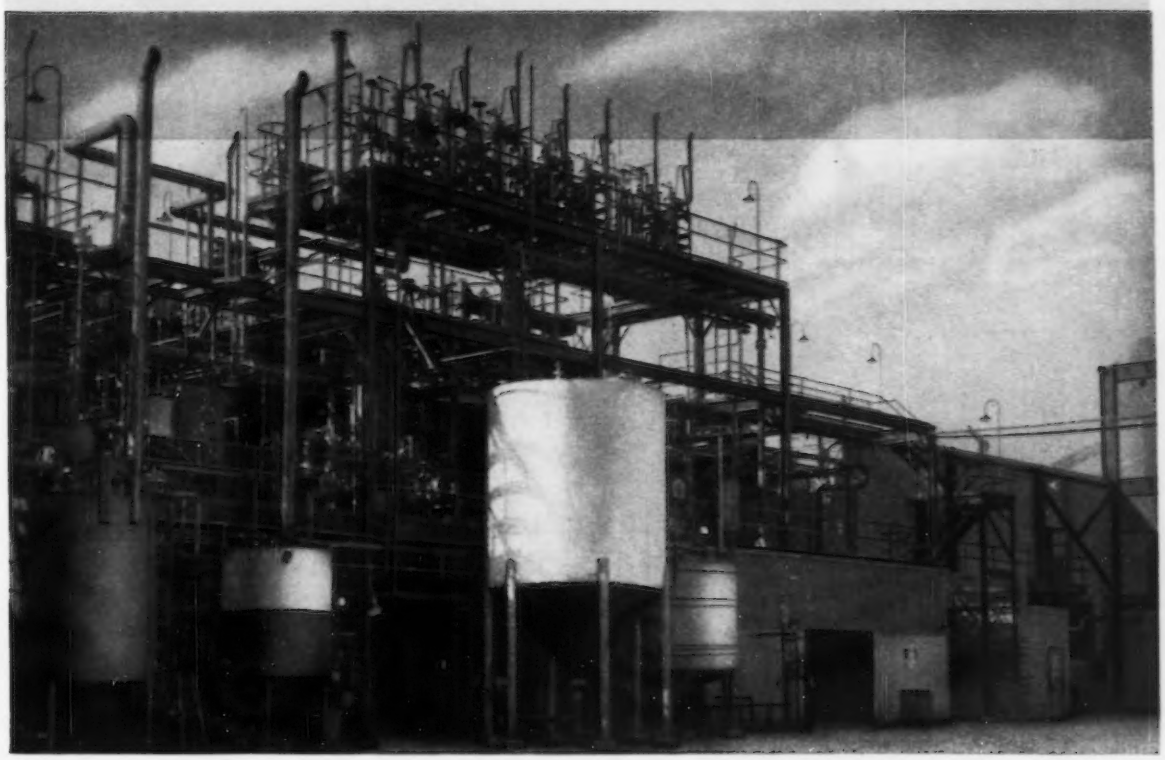
DESIGNED AND BUILT IN JUST SIX MONTHS

Undivided responsibility for engineering, procurement and construction services enabled CATALYTIC to build a new, operating chemical plant in just six months!

This unique performance called for precise coordination between the client and the contractor—to CATALYTIC, this project was a welcome opportunity to meet the challenge of on-time, on-budget performance . . . to show SKILL, EXPERIENCE and IMAGINATION at work.



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Catalytic *On-Time...On-Budget* Services for the metallurgical, chemical, petrochemical and oil refining industries: Project Analysis; Process Development; Process Design; Economic Studies; Engineering; Procurement; Construction.

DENVER *SRL* pumps and parts

OPERATING IDEAS

Radar Now Cuts Map Survey Time

QUICK AND PRECISE LENGTH MEASUREMENTS in mapping (unaffected by rain, fog or darkness) are now obtained by an electronic tool which operates on radar principles.

The device (Tellurometer), developed in South Africa and recently tested by Aero Service Corp., measured distances of 27,414 ft within 4 in. and, according to Aero, will cut basic ground mapping costs and time by 75% or more.

Tellurometer, measuring by phase comparison, consists of two stations, a "master" and a "remote." The "master" contains a 10 megacycle crystal oscillator which transmits a pulse that is compared with pulse from "remote's" similar oscillator.

New system cuts a regular two-day 27,000 ft survey to one hour and will be used by Aero for measurements ranging from ½ to 30 miles or more.

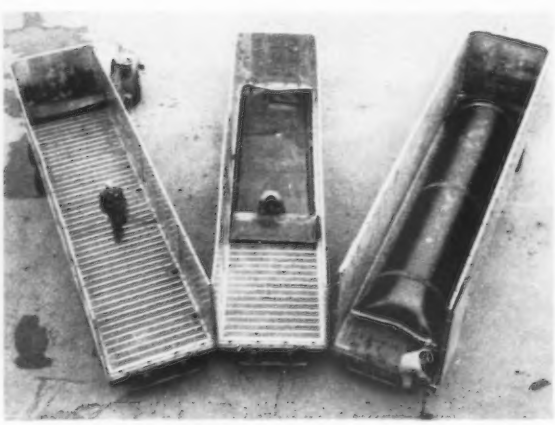
Easily Moved Rig Speeds Drilling

FASTER DRILLING, increased maneuverability, and greatly reduced costs were obtained at Nally & Boone Quarry, Greensburg, Ky., when they recently tested a Schramm Rotadrill mounted on a Heavy Pneumatractor.

The drill and self-propelled, rubber-wheeled compressor are in one unit and can easily be moved from place to place. Once rig is initially set up, drill can be moved about without lowering the mast.

Through hard limestone, the drill increased penetration rates by 55 to 66% and, because chips were cleaned out of the hole as soon as they formed, bit life was extended by as much as 35 to 300%. Hydraulic downfeed control gage, pressure regulator, and all other drilling controls are mounted in a single bank on the compressor.

At Nally & Boone's test, 13 blast holes (830 ft total) were drilled in four days at a cost of only 4½c per ton of rock removed. Itemized test costs included: depreciation (43¼hr. @ $1.50)—$65.25; gasoline (190 gal @ .30)—$57.00; oil (1 gal @ .30)—$1.60; bit (3)—$207.50. Total labor costs, straight time plus overtime, (32 hrs @ $1.25 and 11½ hrs @ $1.87) totalled $61.50.



Truck Becomes Dry-Liquid Hauler

PRACTICAL, COST-SAVING, dry-liquid, two-way haulage on same truck, rail car or barge is now possible with a collapsible rubber container made by the U. S. Rubber Co.

Called Seald.ank, the bag is placed on truck trailer, filled with liquid, and shipped to destination. There it's emptied, rolled up and left on the trailer as a compact bundle (25 in. by 7 ft 4 in.) while truck makes return trip as a dry hauler.

Sealdtank can be made in any size to fit any carrier. A 3,800-gal bag (56in.x35ft and weighing 1,040 lb) is the most practical trucking size. Other bags for other purposes include a 6,500-gal size for the railroad industry and 10- to 20,000 gal sizes for barges and industrial plant storage. Made of four plies of rubber coated rayon tire fabric, Sealdtank is fastened securely at both ends by metal closures, and outer coated with neoprene. Interior may contain rubber compounds to make possible the handling of almost any type material, including some highly corrosive chemicals.

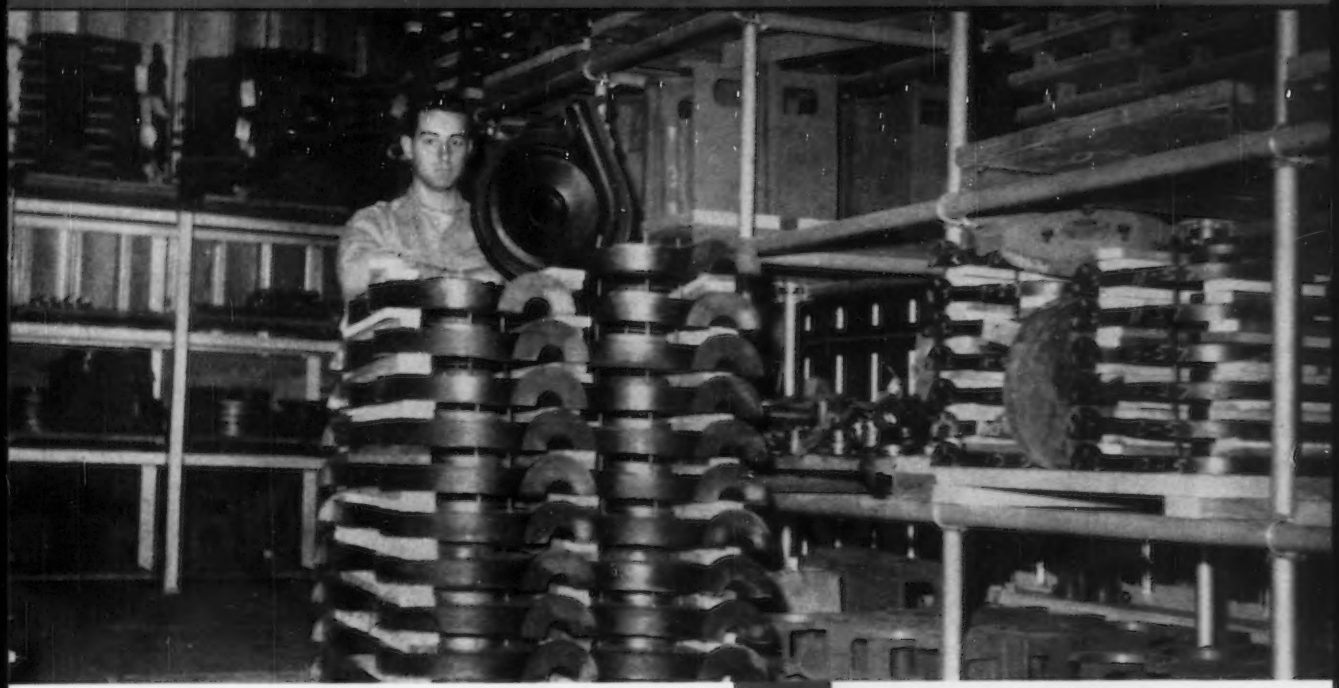
Drift Drainage Can Cut Downtime

DIGGING DRIFT DITCHES and keeping track clean, to prevent water and mud from splashing into bearings, would reduce locomotive breakdown, according to Robert Austin, repairman at U. S. & Lark Mine, U. S. Smelting & Refining Co.

Roller replacement is a major slusher maintenance snag—Mr. Austin thinks they are mounted too close to chute mouth. To dump bucket, operator must pull the bail into the rollers, damaging both them and the cable—from the November 1957 edition of the employee magazine, *Smeltingco.*

DENVER *SRL* pumps and parts are IN STOCK for FAST DELIVERY

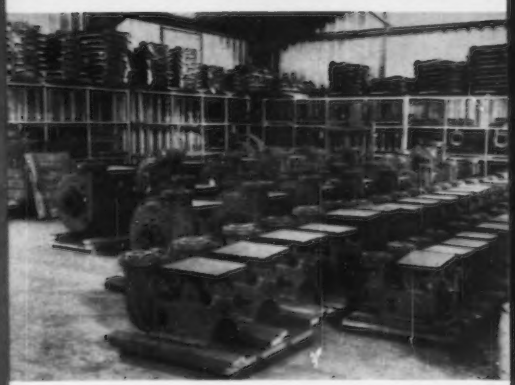
...a service you will like and it costs nothing extra!



If you are buying a pump it is to your advantage to be backed up with a service like this. This FAST replacement parts service means you carry a much smaller inventory of parts.

Thousands of SRL Pumps are in service throughout the world. For years recognized as the most efficient pump for handling sands and slurries.

LOW PRICE—Denver SRL Pumps are priced so low that no operator can afford any pump service less than that of Denver SRL Pumps. Denver SRL Pump Parts not only last longer but cost less than other rubber pump parts.



DENVER SRL PUMP SIZES

Open Runner	Closed Runner
2″ x 2″	3″ x 3″
3″ x 3″	5″ x 4″
5″ x 5″	8″ x 6″
6″ x 6″	10″ x 8″

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- VANCOUVER
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- LONDON
- JOHANNESBURG

OPERATING IDEAS *(Continued)*

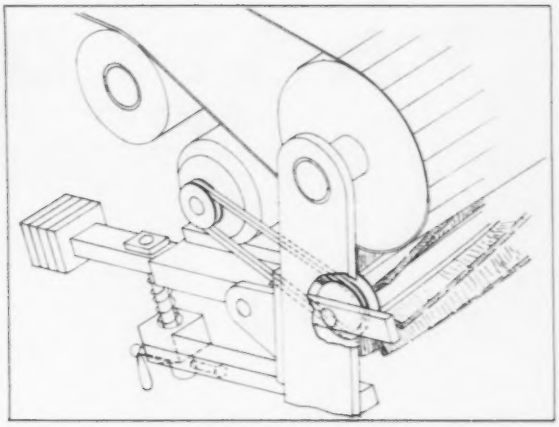
Magnets Find Hammermill Wear

TIME AND COST SAVING SIGNALS are the added features of permanent magnetic separators at Gibsonburg Lime Products Co., president S. G. Price reports.

Eriez separators (Eriez Manufacturing Co., Erie, Pa.) were originally installed to remove tramp iron and iron filings from lime being belt conveyed from hammermill.

Amount of magnet-pulled iron material is normally quite constant and, therefore, as Mr. Price says, "when there is a sudden rise in accumulations of fine iron on the magnets, we invariably find that the hard-surfacing on the hammers has worn through and the body of the hammers is beginning to abrade. The hammers are promptly changed, with the result that potential trouble is avoided."

Gibsonburg has also installed an Eriez non-electric magnetic pulley which separates iron contamination from belt.



Spiral Brush Stops Carry-over

COST-SAVING, HEAVY DUTY, strip-type brushes (with spirally arranged strips and enough space between to allow each to flex itself clean) have been developed by Cleveland's Osborn Manufacturing Co. to eliminate conveyor belt "carry-over."

Osborn's "Rotamaster" is usually located at a point after the belt has unloaded and before it passes over the snubber roll. This solves a major maintenance headache—belt-sticking material collecting on snubber rolls, increasing belt tension and/or causing a damaging abrasion surface.

Cleaning unit may be operated and controlled by several workable methods. One scheme has brush run by belts from the header roll, counterweighted to maintain belt contact, and with a dampening spring to insure uniform cleaning.

Osborn manufactures 16, 18 and 24 in. sections which may be ganged together for any desired width.

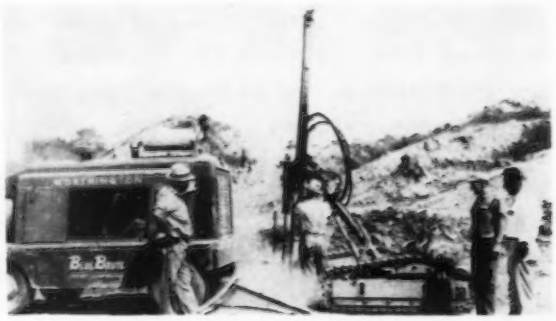
Making A Profit On Overburden

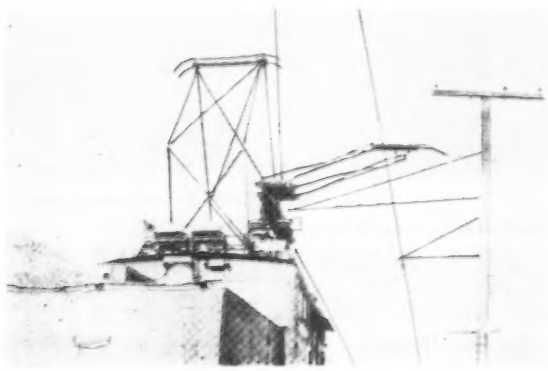
PROFITS ARE NOW GOTTEN from once useless aggregate rock by changing drilling procedure at Mullett Coal Co., Mt. Eaton, Ohio.

Rock, part of 25 to 40 ft. overburden, had previously been piled in quarry spoil banks until president Atlee Mullett figured that if 180 blasting holes 4 ft deep were drilled in an 8-hour day to give a 1,200 tpd stone yield, the former waste could be turned into a profit.

Worthington Port-A-Trac self-propelled wagon drill produced the 180 holes in 6 hours (higher rate than that of two standard wagon drills).

Manpower-saving Worthington used a 1-¾ in. bit on an 8 ft drill rod powered by its 315 CFM portable compressor.





Inclined Wire Shaves Rail Costs

ELECTRIC LOCOMOTIVE PANTOGRAPH DAMAGE has been greatly reduced by inclining overhead trolley wires near change-over stations at Kennecott's Utah Copper Division's mine railway.

Along the mine-to-dumps rail line, at areas where an overhead wire might hamper shovel movement, the company used a side collector wire. At these change-over stations (49 along length of route), if pantographs were released to go up before train was beneath overhead wire, they normally extended above wire and were quite frequently torn off. Now, with the overhead wire raised at its dead-ending point, and sloping gradually to its normal height, pantograph, even though prematurely raised, can be eased under wire. For added safety, trip valves limit pantograph rise when train approaches change-over and are triggered to lower it in the event of premature contact.

More Wheat Lamps in More Modern Mines

...month after month, every year!

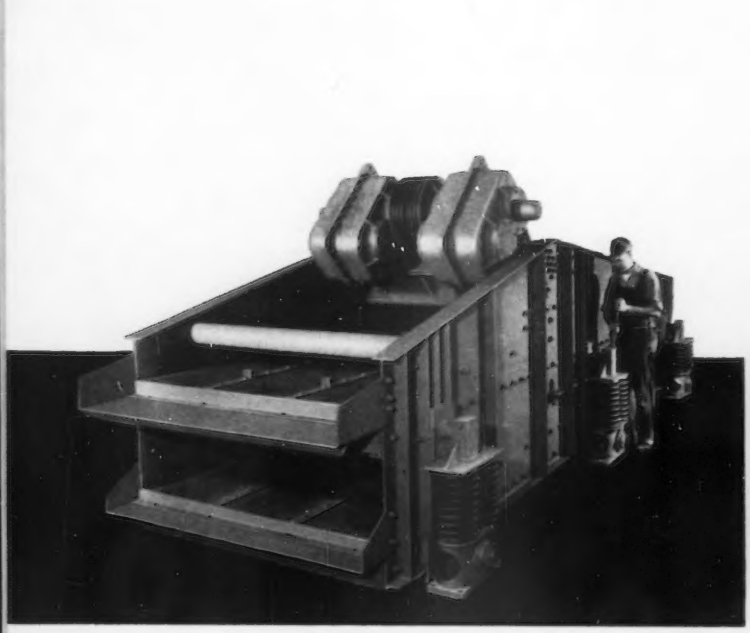
Self-evident value sells WHEAT. Wheat sales forge regularly ahead because Wheat plainly provides *more light* per contract dollar. Wheat sales advance in the largest operations and in the smaller progressive mines—size presents no barrier to the Wheat combination of high-standard lighting and exceptionally low-cost maintenance. Charging is automatic—for one or any number of lamps. *Let us detail the facts.*

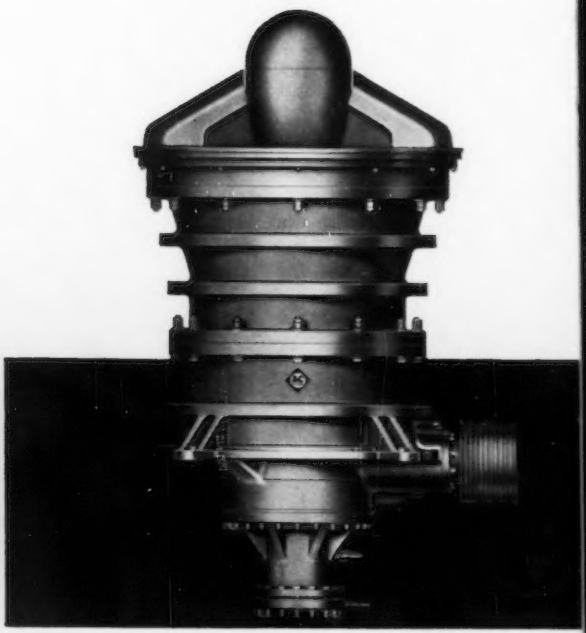
National Mine Service Company

564 Alcoa Building • Pittsburgh 19, Pennsylvania

All-State Division, Logan, W. Va. | Anthracite Division, Forty Fort, Pa. | Ashland Division, Ashland, Ky. | Bemeco Division, Beckley, W. Va. | Clarkson Division, Nashville, Ill. | Kentucky-Virginia Division, Jenkins, Ky. | Western Kentucky Division, Madisonville, Ky. | Whiteman Division, Indiana, Pa. | Mountaineer Division, Morgantown, W. Va.

The Modern Approach





"Coordineered" Equipment **for the**

Mining and Rock Products Industries

Grinding mills — Whether your process calls for individual mills or a grouped-stage grinding series, Allis-Chalmers can make a right-for-the-job recommendation from seven types of grinding mills.

Vibrating screens — Allis-Chalmers screens are built in single or multiple-deck models for use in scalping, wet or dry sizing, washing, rinsing, dewatering and media recovery.

Gyratory crushers — "One-man, one-minute" product control slashes time required to change crusher settings from hours to seconds. Size adjustment, compensation for mantle wear, and emergency unloading are done at the flip of a switch.

"Work Index" Formula

This bulletin explains the "work index" formula — and how you can evaluate any size reduction operation. Compare efficiency of plants, circuits and machines. It offers the only practical approach for improving performance or determining the right machine for a job. Write for Bulletin 07R7995.

A-C ALLIS CHALMERS

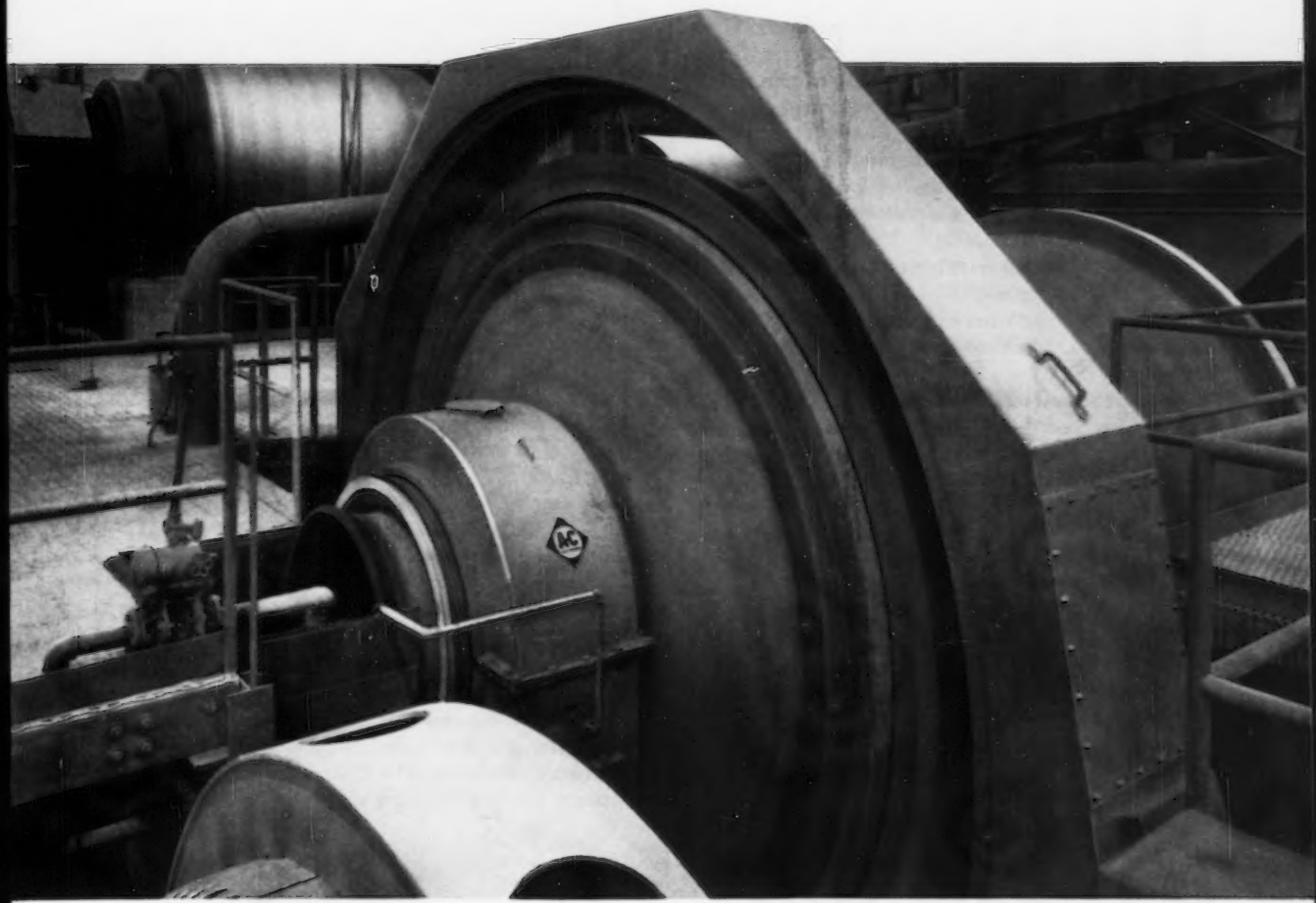
A-5659

to EFFICIENCY!

Practically every type of material mined or quarried is being processed by "Coordineered" equipment from Allis-Chalmers. Coordineering means that product departments work together on a single problem before equipment recommendations are made. Product experts make sure equipment is properly engineered for your specific job — that new units are integrated with both new and existing equipment.

Coordineering draws on Allis-Chalmers unparalleled experience in building and applying industrial equipment. It includes testing in modern laboratory and pilot plant facilities. All to provide profitable processing operations.

Make use of this valuable engineering in the early stages of your expansion or modernization program. An Allis-Chalmers technical team will gladly confer with you or your consultants. Your nearby Allis-Chalmers representative will arrange details. Get in touch with him, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.



ALLIS-CHALMERS

The Year Advertising Helped

This editorial message was first published by McGraw-Hill two years ago. It describes advertising's dramatic contribution to the American economy during 1954. The theme of the editorial—that advertising can help promote economic stability by stimulating sales at a crucial time—is even more pertinent today.

As our economy grows, it is constantly changing. The conditions business faces today are not the same in every respect as those it faced in 1954. But business again has the opportunity, through advertising and other selling efforts, to help sustain a high level of economic activity. At the same time, it will be building markets for the period of renewed expansion that is sure to follow.

This editorial is reprinted exactly as it appeared in 1956 except for minor editorial changes to bring it up to date. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

PRESIDENT

McGraw-Hill Publishing Company, Inc.

IN 1954 we had a business recession in the United States. Sales fell about 4% during the year. If management had followed the historic pattern of business ups and downs, advertising volume would have fallen much further.

But in 1954 the volume of advertising did not fall. It increased over 5%, and expenditures in all major advertising media rose. Every effort was made to stimulate sales when sales were needed to sustain prosperity.

This was something entirely new under the sun. It had a powerful influence in making the recession of 1953-54 one of the mildest on record. It helped greatly to speed business on to the record-breaking levels it attained in the years 1955-57.

There are several reasons why America's business management attacked this decline in sales with more advertising. One of them grew out of the greatly strengthened position of the American consuming market. Consumers' income after taxes has been rising an average of over $10 billion a year since 1946, and this rising income is more widely distributed than ever before. Furthermore, consumers had piled up reserves of about $200 billion in cash or its equivalent. These reserves offered a new and powerful inducement to increased selling and advertising effort even in the face of a possible decline in consumer income. (At the end of 1957, consumer reserves were $225 billion.)

Taking the Longer View

However, the principal reason why a sales decline was attacked with increased advertising is management's new-found conviction that good advertising is essentially an investment in the development of a market. Successful development requires sustained investment. The inclination of business management to take this longer view is, of course, motivated

McGraw-Hill PUBLISHING COMPANY,

ABP HEADQUARTERS FOR

Kill a Business Recession

by the fact that the American market, with over 3 million consumers being added annually, is growing at a prodigious rate.

Ten years ago only a handful of companies had plans for investment in new producing facilities extending beyond the current year. Today almost all leading companies have investment programs running some years ahead. And keeping pace with these long-range investment plans has been the development of sales and advertising programs to reach tomorrow's greatly expanded markets.

Advertising's Key Role

This crucial role of advertising in providing driving power for our economy is gaining greater recognition every day. In his book, "People of Plenty," Professor David M. Potter of Yale University remarked: "Advertising is not badly needed in an economy of scarcity, because total demand is usually equal to or in excess of total supply, and every producer can normally sell as much as he produces. It is when potential supply outstrips demand—that is, when abundance prevails—that advertising begins to fulfill a really essential economic function."

Today abundance so completely prevails in the United States that it has been conservatively estimated that as much as a third of everything offered for sale falls in the realm of "optional consumption." That is, consumers can "take it or leave it" without any immediate personal inconvenience. But if they decide to "leave it," a terrific economic depression will not be far behind. In such circumstances, advertising—in which, in all of its forms, we are now investing over $10 billion annually—clearly is of crucial importance to our continued prosperity.

In performing its key role in past years, American advertising never realized its full potential. It successfully promoted sales. But it never was called upon to promote an overall economic stability as a direct outgrowth of increased sales.

By successfully promoting both sales and economic stability, as it did in 1954, advertising surely has added new strength to the American economy. It has also added a great new and constructive dimension to advertising itself.

One of the surest means of expanding your sales volume in today's industrial markets is through dominant advertising in the publications directly serving your major customers and prospects.

McGraw-Hill's business and technical publications can give you quick access to the men who initiate, specify and approve the purchases of industrial products and services. Because all are leaders in their respective fields, you are assured a maximum return on your advertising investment when you *concentrate* in the McGraw-Hill publications serving your most important markets.

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BUSINESS INFORMATION

At the Rock of Ages granite quarry in Barre, Vermont, a derrick with a bucket platform is used to lower crews to the bottom of the 360-foot quarry. With the lives of scores of men at stake they know that they can...

...lower away in safety

You may not operate derricks carrying ten-man loads or 50-ton blocks of granite, *but safety should be just as important to you.* A "bargain" rope may save you money —but if it fails it may cost more than you bargained for. Buy rope on the basis of quality—buy Wickwire Rope.

CF&I

WICKWIRE ROPE
A CF&I PRODUCT

LOOK FOR THE **YELLOW** *TRIANGLE*

PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION

THE COLORADO FUEL AND IRON CORPORATION—Albuquerque • Amarillo • Billings • Boise • Butte • Denver • El Paso Farmington (N.M.) • Fort Worth • Houston • Kansas City • Lincoln (Neb.) • Odessa (Tex.) • Oklahoma City • Phoenix • Pueblo Salt Lake City • Tulsa • Wichita • **PACIFIC COAST DIVISION**—Los Angeles • Oakland • Portland • San Francisco • San Leandro Seattle • Spokane • **WICKWIRE SPENCER STEEL DIVISION**—Boston • Buffalo • Chattanooga • Chicago • Detroit • Emlenton (Pa.) New Orleans • New York • Philadelphia

Man-hour protection for working crews . . . the Edison R-4 double-filament bulb

Working crews are assured greater underground safety, more productive man-hours because the Edison R-4 double-filament bulb is on the job.

Miners equipped with this bulb know that burn-out doesn't mean blackout. If one filament burns out, a turn of the switch transfers the power of the unfailing Edison battery to the second filament—continued, brilliant illumination is restored for the full shift. There's no lost time for the miner, or short crews for the foreman. There is only *one bulb*, located in the center of the headpiece, which gives the advantages of maximum reflector area.

This kind of reserve light protection means that hundreds of man-hours may be saved every year. The result is increased production with an added margin of safety. Our bulletin gives complete details. Write for your copy.

Edison R-4 Cap Lamp . . . ideal for self-service systems.

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When you have a safety problem, M-S-A is at your service . . . our job is to help you

MINE SAFETY APPLIANCES COMPANY
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At Your Service: 77 Branch Offices in the United States and Mexico

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WASHINGTON IMPACT

Highlights

RECESSION INDICATORS—Recent Government reports and surveys bear out the claims of metal and mineral mining and processing industries that the current recession is hitting them harder than other segments of the economy, and harder than the economy as a whole.

The following indicators, taken from the latest periodic Government statistics, show how metal and mineral mines and manufacturing plants are feeling the pinch in February 1958, as compared to a year ago, and their relative troubles compared to over-all industry groups:

• Unemployment. This is the indicator many metal producers are pointing to as one of their most serious economic problems. In February 1958, metal mines had 96,600 workers on their rolls, according to the Labor Department's Bureau of Labor Statistics—a drop of 13,600 from February 1957, or 12%. All mines, including coal, were down less than 5%, and the nonagricultural total drop was under 3%. Only nonmetallic mines and quarries made a better showing, employing 108,200—only 1% below a year ago.

Primary metal manufacturers worked 1.1-million people, down about 17%. Fabricated metal product manufacturers employed 1-million, a dip of more than 9%. All manufacturers' rolls totalled 15.6-million, down 7%.

• Planned capital investment. Commerce Department and Securities and Exchange Commission has come up with an estimate of how much industry plans to spend on new plants and equipment in 1958. It shows the mining industry as a whole figures to lay out over $1-billion, but $185-million, or 15%, less than it spent last year. The national total projected for 1958 is more than $32-billion, down 13% from last year.

Nonferrous-metal manufacturers plan to spend $470-million, or 42% less, while the total for all durable goods manufacturing is $6.2-billion, down 22%.

• Wholesale prices. Labor Department indicators show that for February 1958, metal and metal product prices were 0.9% below a year ago, while prices for all commodities averaged 1.6% more than in February 1957. Nonmetallic structural minerals registered a 2.9% gain, but this was caused by increases in the price of sand, gravel and concrete block. Nonferrous prices were down 12%.

These figures, of course, will not go far toward changing the minds of Congressmen and Government officials who oppose new Federal support programs for domestic mines on the grounds that production and prices have been based for some time on an unrealistic wartime demand that no longer exists.

FREIGHT RATE HIKES—The "lawfulness" of recently granted freight rate boosts will be determined by the Interstate Commerce Commission under a complex procedural hearing which began last month and runs into May. The new railroad rates which went into effect Feb. 15 pending the ICC investigation average 2%; the roads are asking boosts averaging 3%.

The hearings will involve five categories of investigations: (1) the roads' revenue requirements; (2) line-haul rates on such classes of freight as mine products; (3) special charges; (4) free time at ports; (5) the economic effects of the rate increases on communities, markets and carriers.

Supporting arguments were due March 25, opposition statements must be in ICC's hands by April 22, and written rebuttals have a May 6 deadline. Cross-examination of witnesses starts May 19, on categories 1 and 5.

URANIUM MARKETS—Uranium producers presented a united front before Congressional hearings on the state of the atomic energy industry last month. Protesting recent Atomic Energy Commission uranium purchase program cutbacks, they suggested a number of Federal support remedies that ranged from outright stockpiling to production incentives and other market guarantees. Considerable interest on Capitol Hill has been stirred by the proposal that the Government help domestic uranium producers tap what is expected to be a growing market overseas.

Increased Interior Dept. Aid Appears Unlikely

The story behind Sen. James E. Murray's (D-Mont.) latest Interior Committee hearings into the economic health of the domestic mining industries (see p 23) underscores producers' renewed pressure on Interior Secretary Fred A. Seaton's revised long-range mineral support program.

Murray's aim is to show a discrepancy between domestic production capacity for a long list of metals and minerals on the one hand, and U.S. consumptive and military defense requirements on the other. The idea is to show that the nation is trending toward more dependence on foreign supplies. That's why he called Interior and Commerce Department officials as his first witnesses to establish those figures for the record, with industry representatives and Western State Governors following up with a repeat of their current recession problems (see highlights column, this page).

The chairman hoped to lead off with Seaton. But the Secretary, who has promised to come up with an expanded version of the long-range package of supports he offered last year to cover "a wider range" of minerals, said he won't have it ready until the latter part of this month.

Aside from lead and zinc, awaiting tariff relief, Murray wants to get Federal help for these metals and minerals: antimony, bauxite, boron, cobalt, copper, fluorspar, gypsum, iron ore, magnesium, manganese, mercury, mica, molybdenum, phosphate, potash, sulphur, tin and tungsten.

But Murray's third investigation in as many years into Government mining aids is not likely to spur the kind of support producers are asking. Seaton's 1958 doctrine will contain the same kind of compromises Congress shelved last year. As one Interior official put it when asked what the program will include: "Crumbs."

This is not to say there won't be some new benefits, based largely on research and development incentives. But limited production bonuses, tax benefits, Federal purchases and tariff protection for a few commodities are all the Administration as a whole will approve in light of its collective stand against renewed stockpiling, high trade barriers, or even wide-scale tax relief. In the case of tungsten, even the purchase funds and development loans approved by Interior have been killed in the House by Rep. Michael J. Kirwan's (D-Ohio) long-standing and persistent opposition.

The key question is whether industry pressure, heightened by the sting of the current economic recession, can turn White House policy 180 deg and head it back toward substantial subsidies. Most experts in Washington are calling that a slim hope at best, barring a real domestic depression.

Tariff Relief Bills Still Face Stiff Opposition

Industry hopes for tariff relief are brighter than for any other Government support. Centering around the Reciprocal Trade Agreements Act extension bill, proposed amendments protecting domestic producers from foreign competition depend to a large degree on the form in which that bill is considered by the House. It is expected to reach the floor for debate shortly after Easter recess. If it is brought up under a closed rule, the House members must accept it as voted out of committee, or reject it in toto, or send it back to the Ways & Means group. If it comes up under an open rule, it may be amended on the floor.

Some protection-minded Congressmen are holding out for amendments which will greatly reduce the President's tariff negotiating authority, or transfer that power back to Congress where they argue it belongs under the Constitution. Others are trying for specific commodity import quotas, including curbs on foreign shipments of copper, lead, zinc, fluorspar and other metals and minerals, including those covered by the Murray hearings.

Still others, backed by some mining interests, are supporting a complete and sweeping revision of the entire trade policy structure, which would set up a new foreign trade board to replace the Tariff Commission, with complete power to handle all trade regulation subject only to Congressional approval. A bill along these lines has been introduced by Rep. William Jennings Bryan Doran (D-S.C.), and referred to the House Ways & Means Committee, where it is expected to hit stiff opposition, however.

Administration spokesmen have told the House committee they would go along with some procedural amendments and even specific commodity quotas in the interest of getting a trade bill passed at all.

Once through the House, the trade act extension will hit even stiffer opposition in the Senate.

Late Developments

House Small Business Committee is continuing its investigation into supply and demand situations in aluminum markets, where small users have charged big suppliers are shutting them out with long-term contracts with big customers. American Die Casting Institute secretary David Laine testified so-called hot-metal contracts are giving integrated producers an increasing share through "captive" processing shops. Aluminum Ltd. president Nathanael Davis said he fears for the small customers his company helped to build up in the U.S. Anaconda's counsel C. Jay Parkinson predicted by 1960 aluminum demand will once again exceed supply, though he sees no further replacement of copper by aluminum.

Labor This Month

EMPLOYMENT STILL DROPPING: The nonferrous mining industry is still shrinking. The trend is given fresh emphasis in employment reports for the month of January 1958, released late in March by the Bureau of Labor Statistics. Here's how they go:

- Primary smelting and refining of nonferrous metals, 62,700 at work, compared with 64,700 in December.
- Secondary smelting and refining, 13,400 in January, against 13,800.
- Rolling, drawing and alloying, 104,500 on the job in January, down from December's 107,600.
- Nonferrous foundries had 68,500 employees in January, as compared with 71,800 in December.

Official corollary figures—in other words, those showing industry's unemployment in detail—are not available, but if they were they would show a rising trend. As of mid-March, the International Union of Mine, Mill and Smelter Workers estimated 15,000 miners and smeltermen were out of work.

LABOR AGREES ON ANTI-RECESSION MOVES: Quite suddenly, the over-all business slide—which shows signs of being stickier and hanging on longer than anyone thought probable a few weeks back—becomes the paramount issue for everyone in Washington.

Big labor called 1,000 top unionists to Washington at mid-March for a rally under the theme "Put America Back to Work!" AFL-CIO president, George Meany, prescribed for the economy—a big tax cut for individuals, improved and more liberal benefits for the unemployed, multi-billions more in Federal spending on public works and defense. The timing was fairly opportune. The rally coincided with official announcement that February's unemployment was past the 5-million mark.

The AFL-CIO program coincides on most major points with anti-recession recommendations of the Mine, Mill and Smelter Workers union, which was in its annual convention at Denver while the AFL-CIO economic conference was being held at Washington.

Congress and the White House are not far apart from labor in principle on most anti-recession steps, but there are vital differences in timing and emphasis. Labor would, for one example, give a tax cut only to individuals; it's fairly clear that the Administration would balk at any tax reduction that did not extend to both individuals and business.

THE POLITICAL CLIMATE CHANGES: The recession has only reinforced and strengthened convictions that there will be no major pieces of labor legislation enacted by this Congress. The domestic economy and the race for outer space are much more attractive issues, especially in an election year and especially when public sympathy tends to be aroused for the unemployed, who in turn tend to be identified in most instances with organized labor.

One legislative item—Sen. Paul Douglas's bill to require full disclosure on welfare funds—is likely to be scuttled not by labor (which wants it passed) but by business. It's the sort of bill that, if it is to be passed, will apply to all welfare funds, not just those administered by unions. Insurance companies, the Chamber of Commerce and the National Association of Manufacturers are against any such coverage. One reason is that it would multiply bookkeeping chores for them, but more important is that they would have to lay bare their welfare fund investment portfolios. They are dead set against that.

NLRB VS. TAFT-HARTLEY: Prof. Sylvester Petro of the New York University School of Law has written a new book, "How the NLRB Repealed Taft-Hartley," for Labor Policy Association, Inc., a year-old, business-oriented non-profit District of Columbia organization. The theme of the book (the Association's first publication, which sells for $2) is that NLRB has frustrated the central Congressional intent of Taft-Hartley to give an employee free choice as to union or no union and it is time to abolish NLRB and turn labor relations over to the courts.

WHAT'S NEW IN U. S. PATENTS

OLIVER S. NORTH

Metal and Mineral Processing

Process for separating columbium and/or tantalum from mineral concentrates containing titanium also. Ammonium carbonate (2,819,146) or ammonium hydroxide (2,819,945) is added to an aqueous solution of fluocomplexes of titanium and columbium and/or tantalum to precipitate the desired values in hydrous oxide form. Precipitate is recovered by filtration. J. R. Ruhoff, G. L. Martin and C. O. Gerfen, assigned to Mallinckrodt Chemical Works. No. 2,819,146 and 2,819,945.

Treatment of finely divided sulphide ores or concentrates under solids fluidizing conditions. Fines are fused into agglomerates, and the agglomerate bed maintained in fluidized state by increasing velocity of fluidizing gas. Increased turbulence prevents complete fusion of bed into undesirable masses. Minerals which may be treated by this method include galena, spalerite, pyrite and pyrrhotite. F. A. Fischer, assigned to Door-Oliver Inc. No. 2,819,157.

Separation of plutonium compounds from aqueous or organic solvent solutions. Products are chelate compounds of tetravalent plutonium. F. J. Wolter and H. C. Diehl, Jr., assigned to U.S. Atomic Energy Commission. No. 2,819,280.

Process for treating copper or zinc sulphide ores with hot gases. Ore is fed to a movable conveyor and covered with a permeable layer of granular heat exchange material, for example mullite. Hot gases of any concentration and purity may be drawn through the composite bed. Finally, a cool treating gas is drawn through bed. H. Rausch and K. Meyer, assigned to Metallgesellschaft Aktiengesellschaft. No. 2,819,539.

Specific gravity separation of ores, such as galena, tin, magnetite, etc., from gangue materials. Water suspension of ore is treated in a cyclone of unique dimensions. Two fractions are produced, one consisting of heavy particles and the other light particles. F. J. Fontein and C. Dijksman, assigned to Stamicarbon N. V. No. 2,819,795.

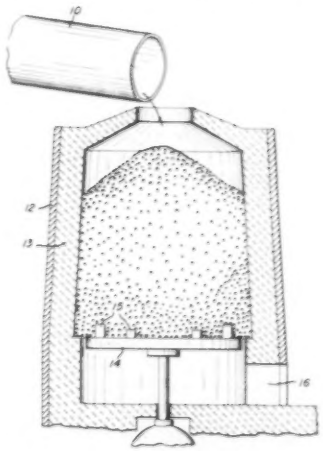
Power-driven, micro-adjustable screen for separating or sizing sands, ores, etc. Device eliminates screen clogging, permitting free passage of powdered material. Motion of discharge end can be adjusted to control flow of material. Screen is simple in construction, easy to install and operate, and efficient and durable in use. F. H. Edwards. No. 2,819,796.

Apparatus and process for separating asbestos fiber from rock and for cleaning the fiber without the use of air blasts or suction. Better removal of adherent dust is effected by use of a travelling inclined screen. Crushed ore is batch-fed to screens at intervals, and screens allowed to clear between feedings. C. V. Smith. No. 2,819,846.

Separation of molybdenum from uranium in ether solution obtained during acid digestion of pitchblende ore. Solution is contacted with activated charcoal. Molybdenum-containing charcoal then is separated by filtration. Process removes molybdenum to a high degree with virtually no loss of uranium. H. L. Wibbles and E. I. Miller, assigned to U.S. Atomic Energy Commission. No. 2,819,944.

Ore reclaiming apparatus and method for blending fluxes and ores prior to smelting or other operations. Series of piles of ore and flux are prepared, with each pile containing enough material for a certain period of operation. Overhead mechanism cleans up an ore-flux assemblage by harrowing the material in one direction to a receiving tunnel and, after making a turn, can reclaim a bed on the opposite side of the tunnel. Mechanism does not have to be shifted back and forth, but instead moves in a continuous working path. The harrowing action breaks up and mixes beds of partially stratified material, so that a uniformly proportioned feed is sent to smelter. J. H. V. Finney and F. B. Maychark, assigned to Bunker Hill Co. 2,820,553.

COPIES of U.S. patents can be purchased at 25c each from Commissioner of Patents, Washington 25, D. C.



Method for improving mechanical strength and reducibility of partially fused taconite or other iron oxide agglomerates. Hot pellets from rotary kiln or like device are cooled to finishing temperature of about 300 to 600 deg F or almost to room temperature over a period of 12 to 16 hours in a slightly oxidizing atmosphere. Such slow cooling avoids thermal shocks, and oxidizes much of the magnetite present to hematite, which is easier to reduce in blast furnace.

Figure shows in diagrammatic sectional view one form of apparatus suitable for carrying out this operation. Hot pellets are discharged from rotary kiln (10) to shaft cooler consisting of metal shell (12), refractory lining (13), and power driven revolving grate (14), whose upper face carries lugs (15). Opening (16) serves both as air intake and as exit for cooled nodules. Air is circulated continually through shaft. Revolving grate breaks up pellet clusters and assures a uniform and continuous discharge. Shaft has sufficient capacity to hold 12 to 16 hours output of kiln. W. C. Allen and T. F. Berry, assigned to U.S. Steel Corp. No. 2,820,704.

Method for recovering nonferrous metals from mixed metal slags, such as slags derived in the smelting of chalcocite, galena, sphalerite, pentlandite, carnallite, etc. Slag is percolated through a reducing material such as carbon in a CO-CO_2 atmosphere at a temperature of about 1450 deg C and immediately withdrawn. Treatment reduces desired metals to free state while leaving iron contaminant unchanged. Slag is then processed for removal of desired metal from residual slag. J. P. Warner. No. 2,820,705.

Processes for electrowinning titanium, zirconium and hafnium from aqueous solutions or melts containing those metals. F. von Bichowsky. No. 2,820,745 and 2,820,748.

Method for removing calcium from sulphate solutions employed in the electrowinning of manganese. Solution is treated with calcium sulphate seeding crystals, for example plus 150-mesh crude gypsum. Resultant slurry is adjusted to a pH below 7.5 and agitated to precipitate $CaSO_4$ on the seeding crystals. M. C. Carosella, assigned to Union Carbide Corp. No. 2,820,749.

Sink-float mineral separation. Simplified and accurate means is provided for maintaining constant the specific gravity and viscosity of the parting liquid. N. L. Davis. No. 2,821,303.

Volatilization method and apparatus for extracting liquid sulphur from pyrites or other metal sulphide ores. S. A. Aannerud, assigned to Pyror Ltd. No. 2,821,461.

Improved process for recovering the highest purity fraction of a mass of electrodeposited titanium metal. Mass is disintegrated by a scissor-like shearing impact, which does not grind up excessively the coarser, higher-grade titanium crystals. L. D. Grady, assigned to New Jersey Zinc Co. No. 2,821,468.

Up-draft stoker type apparatus and method for pelletizing iron ores or similar materials into strong, uniformly hard nodules that are resistant to breakage and suitable for use in blast furnace. E. W. Davis, assigned to Regents of University of Minnesota. No. 2,821,469.

Mr. North is patent consultant, Washington, D. C.

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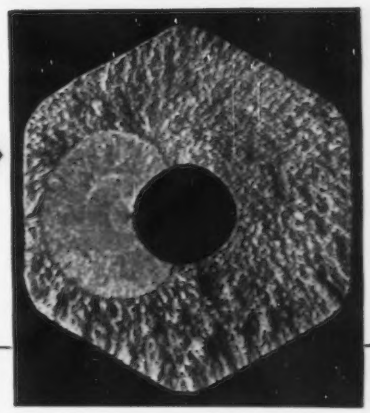

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A FIFTEENTH TERM as president of the Prospectors and Developers Association begins as Mrs. Viola R. MacMillan meets with leading members of the association: (front row) Jack Woods, George A. MacMillan, Tom Aldous, Viola, Gunnar Berg, Cyril Young; (back row) Don Kemp, Joe Rankin, Roy Martin, Gaston Lavallee, Roy Ranson, Jack Brady, Bill Dennis, Aaro Aho, Alec Berry, Gordon Miller.

Canadian Prospectors Maintain Optimism

THE PROSPECTORS AND DEVELOPERS ASSOCIATION enjoyed a record breaking attendance at its annual convention held in Toronto, Ont., Canada, last month. The meeting this year was held jointly with the Geological and Mineralogical Associations of Canada.

Despite a somewhat calmer outlook reflecting the general cutback in prospecting activities, the meetings reaffirmed the optimism characteristic of Canadian enterprise. The present restrictive atmosphere is viewed in the long term as only a passing phase. There is little pessimism for the future.

The meeting was attended by prospectors, geologists, financiers and manufacturers of prospecting and mining equipment. A record attendance of more than 2,000 swelled the many technical sessions. Interest was centered on metals of the space age, outlook for gold and base metals, and mineral exploration in the Ungava nickel-copper belt.

Technical sessions were conducted by a panel of 70 top-ranking representatives of the mining industry together with university personnel who conducted a number of sessions on base metals, gold, developments in the atomic energy fields, geology, airborne and geophysical exploration and economics of exploration in various Canadian mining areas.

Among those presenting papers to the convention were Simon D. Straus, vice president of American Smelting & Refining Co., J. W. Earley and I. H. Milne of Gulf Research & Development Co., Pittsburgh, Pa., C. S. Bacon of Close Institute of Technology, Cleveland, Ohio, E. W. Heinrich of University of Michigan, Ann Arbor, and W. T. Huang of Sul Ross State College, Alpine, Tex.

U.S. participation in Canadian mining has grown substantially in the past decade or more and each convention has attracted a number of enthusiasts from south of the border. Certain measures of the B.C. government against mining, and the threat of tariffs against Canadian exports of base metals to the U.S. came under fire of the association. Resolutions were passed to exert all possible influence to have restrictive measures removed. Other resolutions dealt with access roads in Northern Ontario. The association granted life membership to four veteran members: John Woods, prospector and long-term member of the association, Dr. J. W. Ambrose and Dr. A. W. Joliffe, professors of geological sciences at Queen's University, Kingston, and E. Ebbutt, a geologist.

Mrs. Viola R. MacMillan was re-elected for the 15th consecutive one-year term as president of the association.

Geological Association of Canada, in a separate meeting, elected T. H. Clark, professor of McGill University, as president, and the Mineralogical Association elected Dr. John S. Stevenson, also of McGill University, Montreal, as president. The next annual meeting of the Geological Association of Canada will be held with the Prospectors and Developers Association.

Mineralogical Association of Canada was formed in 1954 for mineralogical research and the dissemination of mineralogical knowledge about Canada. The association is open to everyone, but the emphasis is on Canada. Last year the Association published the first volume of its publication "Canadian Mineralogist" which was well received at home and abroad.

The Geological Association of Canada, founded in March 1947, has a membership of nearly 500 Canadian and U.S. geologists. Its aims are the investigation of mineral structures, collecting and disseminating geological information and the establishment of a central reference library. Membership is not confined to Canada and membership is drawn from many countries including the U.S., Australia, Belgium, Brazil, Denmark, Britain, Italy, Mexico, Peru, Turkey and Northern Rhodesia.

J&L Studies Lease for "Eventual Operation"

JONES & LAUGHLIN STEEL CORP. exercised its option to lease for 100 years a huge iron mining project of 5,640 acres in the Mount Wright area, Quebec Province, from Quebec Cobalt & Exploration Ltd., Montreal. Decision was announced by Avery C. Adams, president, Jones & Laughlin. Cleveland-Cliffs Iron Co. of Cleveland, O., has joined J&L as a partner in this option.

The Quebec Cobalt property is about 180 miles north of Seven Islands, and five miles north of the Mount Wright deposits owned by Quebec Cartier Mining Co. (wholly-owned subsidiary of U.S. Steel Corp.) to which a railroad has been projected. The property is about 40 miles west of the Labrador and North Shore R.R. serving Iron Ore Co. of Canada.

During the last two seasons Jones & Laughlin has spent over $400,000 on exploration and research. Drilling and mapping has indicated approximately 1-billion tons of crude ore, containing iron in sufficient quantity to produce an estimated 335-million tons of iron concentrate, which is the largest property leased by Jones & Laughlin in its ore reserve program, according to the company. Scope of the coming season's operation will involve some drilling and general preparation for eventual operations.

Beneficiated ore, which will be used for a feed for J&L's blast furnaces at Pittsburgh and Aliquippa, Pa., and Cleveland, Ohio, will contain approximately 66% iron. The beneficiated ore has a higher iron content than conventional taconite ore being shipped from Minnesota. The crude ore is both magnetic and non-magnetic.

Under the terms of the lease, Quebec Cobalt & Exploration, in which Thompson-Lundmark Gold Mines has a 40% interest, is to receive minimum advance royalties of $50,000 yearly for a period of two years. Thereafter minimum payments are advanced to $100,000 yearly.

These amounts will be credited against royalties payable per ton on concentrates produced upon achieving production. Lease also contains the usual six-month cancellation clause. A royalty of 60c per ton of concentrates produced is payable to Quebec Cobalt when production is attained, subject to upward revision of 5c per ton for each $1 per ton advance in the Lake Erie price of Old Range non-Bessemer iron ore, the base price being taken at $10.10 per ton. Since the contract was executed on Feb. 14, 1956, this price has advanced to $11.70.

LESS DOWN-TIME WITH "JIMMYS"

24 GM Diesel engines operating at Anaconda Company's Jackpile uranium mine

One of the largest uranium strip mines, Anaconda's Jackpile mine in New Mexico employs GM Diesel power in 3 Koehring Dumptors, 2 LeTourneau-Westinghouse Tournatractors, a Koehring Model 605 shovel, a Bucyrus-Erie 71-B shovel and 17 Euclid hauling units.

Mine Foreman Basil F. Barlow says: "I have been supervising the operation of our various GM Diesel engines for the past five years with the Anaconda Company. I have found these engines very efficient, dependable and reliable. *We have less down-time with 'Jimmys'.*"

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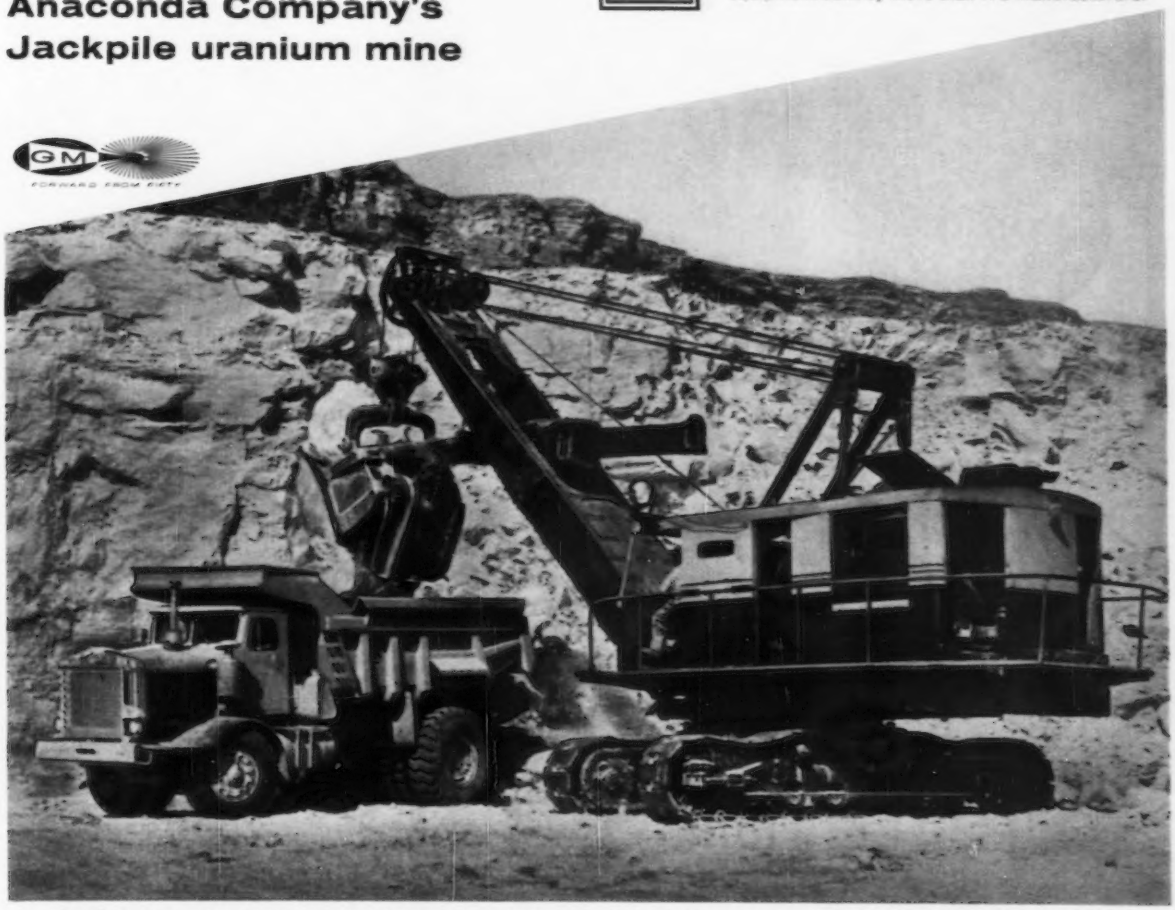
GM FORWARD FROM SIXTY



GM Diesel-powered equipment at Anaconda's Jackpile uranium mine includes "71-B" shovel and "Euc 63TD."

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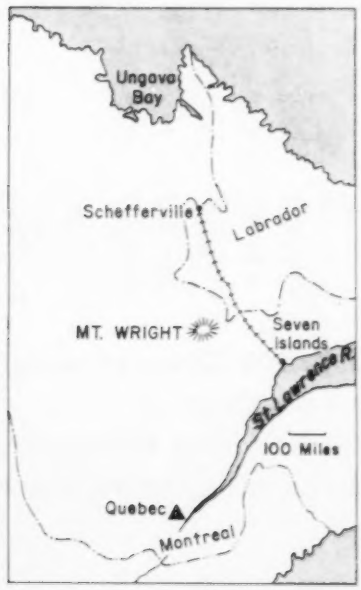
J & L Lease *(Continued)*

There is also provision for a royalty of $1 per ton on any direct shipping ore which may be mined with an escalator clause providing for increased royalties of iron ore prices advance beyond $10.10 per ton. Royalties are subject to revision based on operating profits. Any other minerals which may be found on the property, and are not part of the iron deposits, are expressly reserved for Quebec Cobalt.



WHILE THE CORPORATION has no plans for immediate development of the property," Jones & Laughlin Steel will conduct drilling at the 5,640-acre lease in the Mt. Wright area which it acquired last month. (*E&MJ*, February 1958, p 23.)

Intensive research has been carried out on Quebec Cobalt crude ores using high tension electrostatic methods of recovering specularite and magnetite. Tests to date have yielded extremely high grade concentrates, grading up to 70% iron, with recoveries of up to 97.5%, Quebec Cobalt officials say.

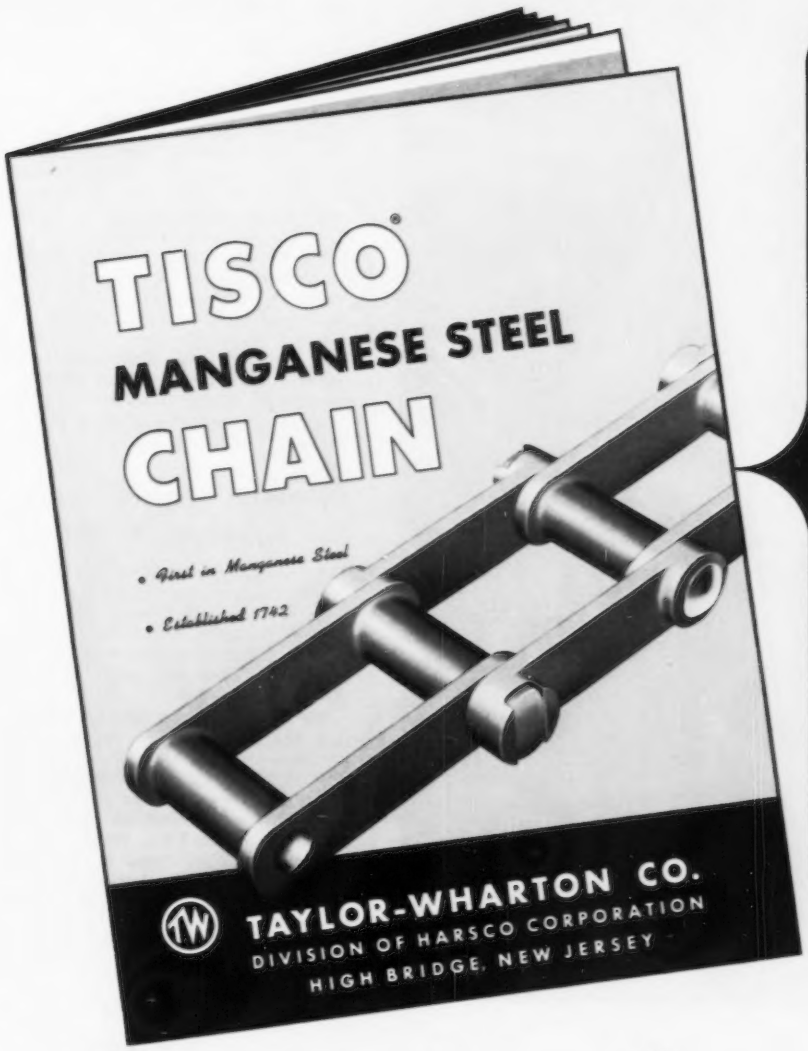
As this process employs a dry feed it obviates the use of large quantities of water required in magnetic and gravity milling.

The Quebec property was originally discovered and developed by Robert D. Hoffman and Arnold Hoffman, consulting engineer and president of Quebec Cobalt & Exploration Ltd., respectively.

IMC Opens Research Lab

A RESEARCH LABORATORY designed to "capitalize to the fullest on today's rich new opportunities in minerals" has been put into operation by International Minerals & Chemical Corp. at its Experimental Research Station in Mulberry, Fla.

Dr. I. M. LeBaron, IMC research vice president, said at the opening that the new mineralogical lab, unique in the



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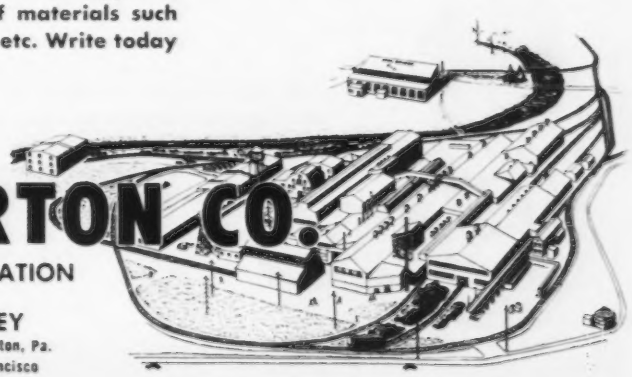

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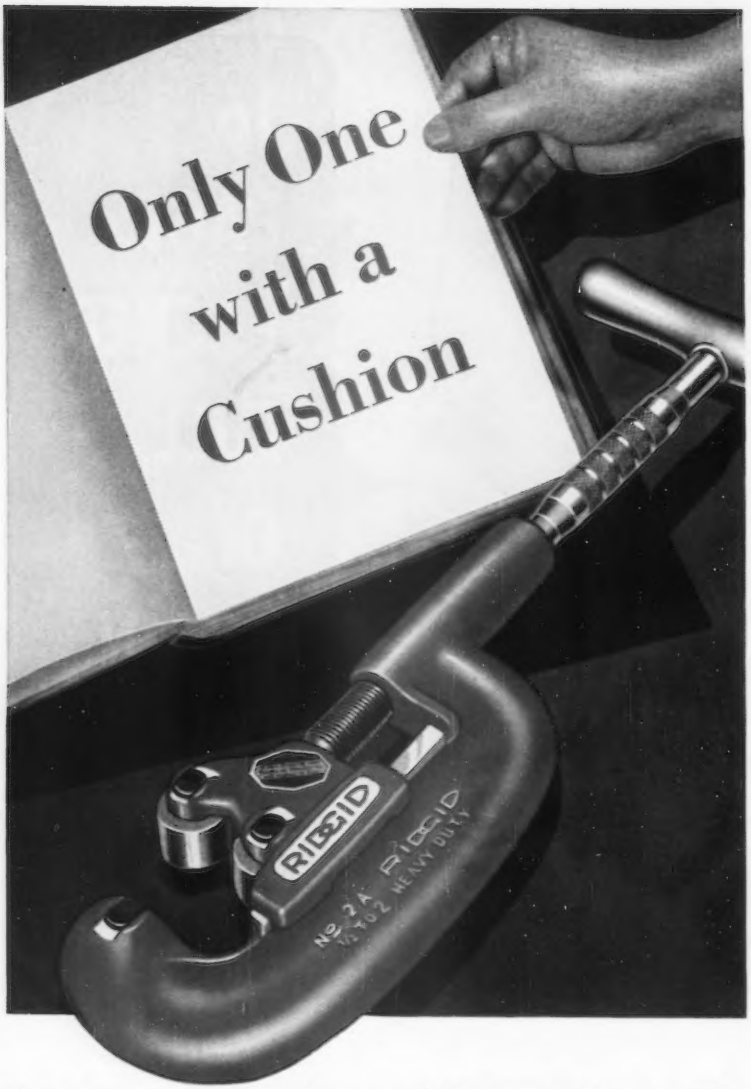

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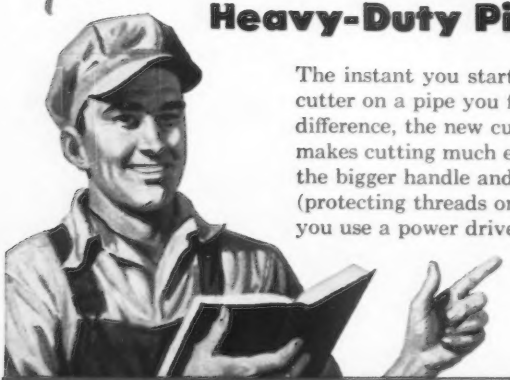

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IMC Lab *(Continued)*

mining industry, would allow full-range mineral investigations, from studying composition of new-found ores to checking out the economic soundness of mining and marketing them.

Equipment for the new laboratory includes facilities for differential thermal analysis, X-ray diffraction, spectography and X-ray spectography, and high-powered microscopic studies.

The Florida station handles about 50% of the company's total research program, some of which was shifted from the main research laboratory at Skokie, near Chicago. Florida station handles inorganic chemistry, chemical processing and engineering, minerals beneficiation, and mineralogy; Skokie handles organic, biological, agronomy and food products research.

Domestic Miners Press For Uranium Stockpiles

THE DOMESTIC URANIUM MINING INDUSTRY is centering its fire on a program for stockpiling of yellow cake.

This would permit a minimum amount of exploration for new ore reserves between now and March 31, 1962, it is alleged.

While the Atomic Energy Commission has announced it "opposed" such stockpiling, the evident failure of the AEC to come up with any alternative program, or even an early solution to its existing moratorium on concentrator expansion in the USA, could result in Congress taking a hand in AEC raw materials affairs this election year.

The "stockpile" program is regarded as the least objectionable of the three principal plans which have been discussed generally in and out of the industry.

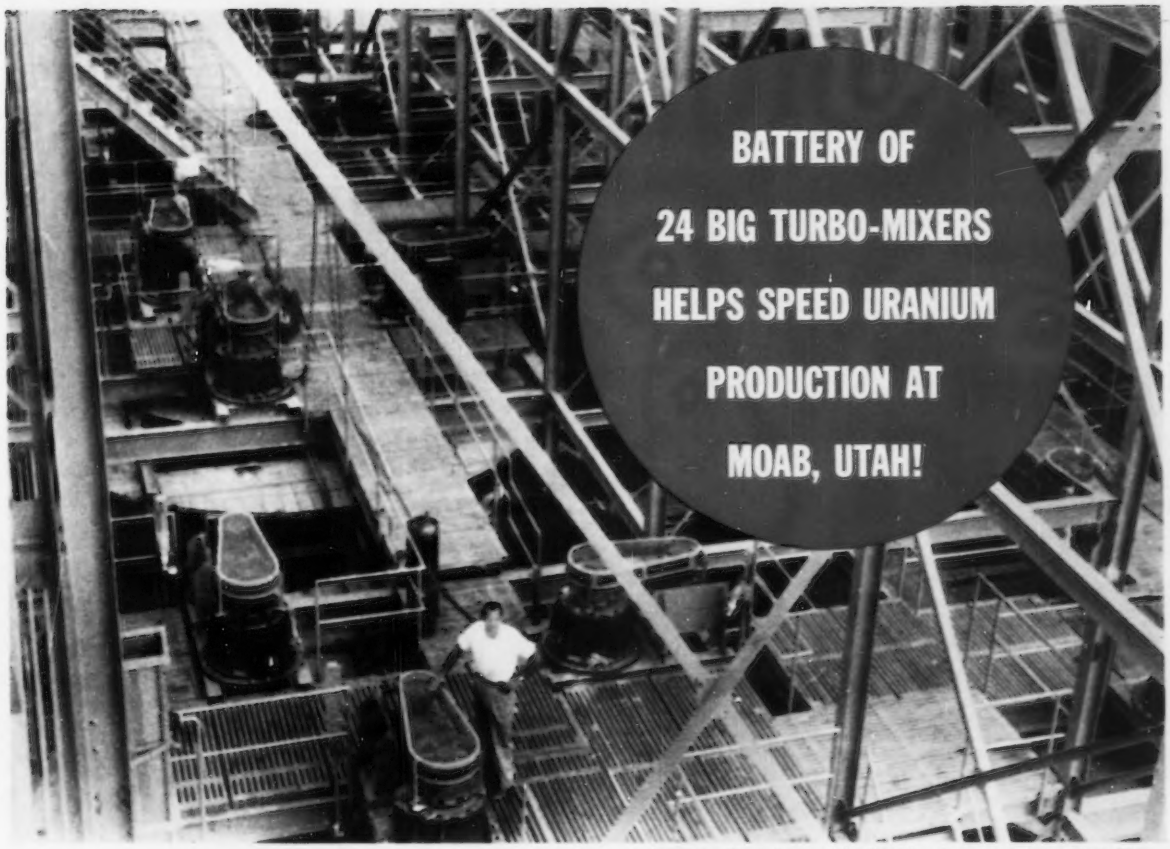
Other two plans include: (1) A very significant increase in appropriations for a speeded up reactor program. But this "crash" plan is linked in minds of some with huge Federal spending for publicly-owned nuclear reactor electrical generating stations—a "TVA without the Tennessee River."

(2) The "New Mexico Plan" which would reimburse the miner for exploration costs if he found a commercial orebody and which also would pay the miner for a certain proportion of its value. All this without any mining of the reserves, of course. When finally mined, the owners would be reimbursed further by the Federal Government.

The chief objections to both these plans is the necessary increase in AEC budget requests. Significantly, the uranium raw materials budget is not linked with the guided missile programs, etc.

While AEC has raised its objections to stockpiling, the proponents are quick to point out that the Commission already is engaged in "stockpiling." The stockpile is in form of enriched uranium salts and metal, etc., they say.

It is estimated that the cost of converting domestic and foreign uranium concentrates received by the AEC during fiscal 1958-59 will come to nearly



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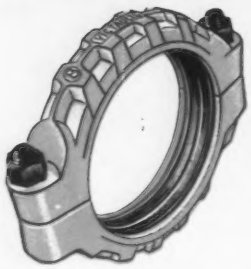

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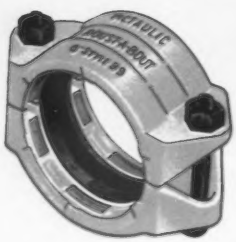

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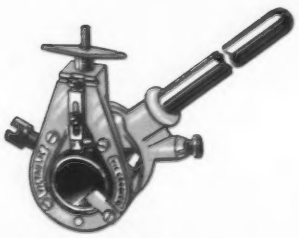

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Uranium "Stockpiling" (*Continued*)

$600-million. What some in the domestic industry propose is that only one of two gaseous diffusion plants in the USA be operated in such conversions.

Funds to be spent in stockpiling metal and enriched uranium would then be diverted to purchase of domestic concentrates. The figure of $150-million a year is mentioned in this connection.

The $150-million would provide for a reasonable added expansion of milling facilities in Wyoming and New Mexico, it is argued.

The AEC also is challenged on the policy of converting all yellow cake to metal—including metal in various shapes. It is pointed out that with the great variety of reactors and multiplicity of defense uses ahead, it would be better to have most of our uranium in a basic concentrate form from which it would be possible to work towards various different finished products. Otherwise, we may face a most expensive re-claiming or conversion problem which would add significantly to the cost of production of finished uranium.

The central issue behind the disturbance in the domestic uranium industry stems from the announcement last fall on behalf of the commission by Jesse Johnson, raw materials director, that (in effect) a lid had to be placed on concentrator expansion.

After some hauling and pulling on part of the domestic producers, they all have in the main now come to the realization that the AEC is faced with a budgetary problem in the raw materials field.

Thus the issues are defined broadly as: (1) The problems of those firms and individuals who have spent large sums of money in development of reserves for which there is not at this time a market, and (2) the end of exploration in the domestic fields for new reserves.

There has been a general institution of rationing of shipments from miners to mills in most areas of the U. S. where mills are now operative. This has caused some firms to revise their estimates of profits.

The tendency to accept higher and higher grade ores and to spurn lower grade ores is increasing, causing additional "unhappiness." Some producers claim the AEC is fostering a program of high grading.

Unemployment in some older areas of uranium development—the Marysvale district of Utah and the Uravan Mineral Belt of southwestern Colorado—has resulted.

The "moral issue" on AEC purchasing has been raised in the industry.

And while the Commission is legally bound only to purchase 1,000 tons annually from any one producer of carnotite-uranium ore delivered at Monticello, Utah, the question of maintenance of an exploration rate for uranium in America is regarded as the one issue in which the public has a stake.

In other words, it may be granted that the Government can cut this or

26 MILLION YARDS IN 30 MONTHS

The 207′ long *Franciscan* digs 50′ deep with ladders at 45°—pivots on two 80′ spuds. 8,000 hp AC synchronous motor driven pump—36″ intake, 30″ discharge.

Seagoing stern provides easy job to job movement. It's powered from shore, but designed for installation of on-board power plant.

9′ cutter head powered by 1,500 hp DC motor, tears tough abrasive Alameda sand deposits never before so successfully handled by a hydraulic dredge.

YUBA HYDRAULIC DREDGE

HALF A CENTURY OF DREDGE DESIGN, FABRICATION, MINING AND EARTHMOVING EXPERIENCE

Built by Yuba for Utah Construction Company, the *Franciscan* has been placing fill for a large Alameda shoreline community development, and for the huge Metropolitan Oakland International Airport expansion. According to John Yasich, internationally known expert and manager of Utah's dredging operations, and Utah Engineer Jack Mednick, this biggest dredge in the West has been doing an unusual job. Whether you're looking for 8″ or 30″ hydraulics—large or small clamshells or bucket ladders—or modernization of present equipment—consult Yuba first.

YUBA MINING DIVISION

DREDGES • JIGS • TROMMELS • ROTARY FEEDERS
DREDGE PARTS • SCREEN PLATES • SLURRY PUMPS
CUSTOM ORE HANDLING EQUIPMENT

675 EAST H STREET • BENICIA, CALIFORNIA

YUBA CONSOLIDATED INDUSTRIES, INC.

Uranium "Stockpiling" (*Cont.*)

that producer off the purchase rolls. But is it in the interest of the Government to end exploration and development of new reserves which would be needed ten years hence?

A public discussion of the problem is occluded by the secrecy which surrounds the AEC programs.

The domestic uranium mining industry is very serious about end of secrecy in the AEC. Of course, the reason for this is simply that through maintenance of a shroud of secrecy over contracts, purchasing, finished uranium throughput, etc., the Government, it is alleged, can and has, exercised an unfair advantage in dealing with private enterprise.

Secrecy surrounding mill contracts seems particularly indefensible at this time, they contend. The Russians could learn little or nothing, of strategic import, and would probably care less, about what price "X" is getting for U_3O_8 versus price paid "Y" in the domestic industry, it is argued.

The important factors in the raw materials business have been process metallurgy, and this has been declassified already. Only the politically sensitive mill contract situation remains "classified."

Meanwhile, AEC insists it is continuing its "study" of the domestic milling situation. It is implied that eventually something will result from this study and that there will be a modification of the mill expansion moratorium.

The domestic industry is divided on this score. The pessimists generally are people who have been in other phases of non-ferrous metals development in last 10 years in the U. S., and are now in uranium.

They declare that their faith in the promises of any Washington Administration to do anything about the mining industry is now at the nadir. A "study" is regarded as only a delaying tactic—a maneuver involving inaction.

Others are more optimistic. They maintain that mining economics may result in re-evaluation of reserves in the Ambrosia Lake district, the largest reserve in the nation.

(Some of the underground mines have a sand-water problem that will create serious drag on profits, it is reported.)

These people also maintain that AEC will come up with a modest expansion in Gas Hills area which may not be satisfactory to everyone, but which at least will enable firms and individuals to "get their money back" from exploration commitments.

AEC also will develop a program for foreign sales of domestically-produced uranium, say the optimists.

Meanwhile, the March 31, 1962 deadline creeps ever nearer. That is why optimists and pessimists alike agree that if anything is to be done to reform the industry, i.e., provide a new basis for exploration for reserves, and satisfy in part the reserves now built up,—it must be done in 1958.

FABRICATED STAR BITS

The Fabricated Star Bit shown here has been designed especially for big hole drilling in hard formations. Far more efficient than the old style spudding bit and the big hole paddle-type bit, these Star Bits are custom-engineered to suit the particular hole size and the capacity of the drilling machine used.

Spang Fabricated Star Bits save labor and money. They can be quickly dressed to gauge, and speedily ready for drilling, by hard surfacing the cutting edge.

For drilling large diameter holes profitably

Here is a Fabricated Star Bit that has been successfully proven on numerous large hole projects. It is available in a wide range of diameters, and weights . . . the lengths in which they can be furnished are directly related to their overall weight.

Complete details and literature on request.

SPANG & COMPANY

DEPT. M-2 BUTLER, PENNSYLVANIA

For over 60 years Manufacturers of Spang Weldless Jars and a Complete Line of Cable System Drilling and Fishing Tools for Oil and Gas Wells, Prospect Drilling and Shot Blast Holes.

Lucky Mc's Column Ion Mill Approaches Full Capacity

LUCKY MC URANIUM CORP. announced it had successfully placed its column ion exchange uranium mill on stream at Gas Hills District, Fremont County, Wyo.

The 750 tpd concentrator was expected to hit full pace of production in 30 days, according to general superintendent A. V. Quine, a former employee of Goldfield Consolidated Mines Co. and graduate of Colorado School of Mines.

The Lucky Mc "story" rivals in some respect that of the Charlie Steen story in domestic uranium.

It was Neil McNeice, a Riverton, Wyo., machine shop operator who first found uranium in the Gas Hills district on Sept. 21, 1953.

That discovery was in the oxidized zone of the Wind River formation, which was in later years to yield heavy and uniform concentrations of uraninite material at depth amenable to open pit development.

Today, the Gas Hills district is given a proved, productive 20 million tons of uranium ore, most of which can be exploited by open cut, relatively low cost

Column Ion Mill *(Continued)*

mining. Fully half of these reserves are controlled by Lucky Mc, according to firm vice president W. H. H. Cranmer, Salt Lake City.

It was this veteran mine leader and president of New Park Mining Co. who made the original deal with McNeice and associates—and then took the proposition to Utah Construction Co., worldwide mining firm.

U-C agreed to develop reserves, secure a milling contract and furnish financing for the venture in exchange for 60% interest in Lucky Mc.

Mr. McNeice and associates and New Park associated companies holding remaining interests—along with the public.

Robert R. Porter, Salt Lake metallurgist, designed the column ion exchange system and is consulting metallurgist on the process. This is one of the largest and first such processing systems to become operative in the domestic uranium industry.

Over-all direction of operations is under J. A. Mecia, president and managing director of Lucky Mc. and vice president of mining at San Francisco for U-C.

The firm has a proposal, with Phelps Dodge Corp., for expansion of the mill 1½ miles from three open cut operations in the district, by 1,000 tpd. This pends before AEC.

Some 160 persons will be employed in mining and milling at the operation. About 30% of the ore run in first year's operation will be on custom basis. Public dedication of mill comes later in 1958.

Chino-Russian Survey Reports Mineral Finds

A JOINT HYDROELECTRIC and minerals survey of the Heilungkiang-Amur river valley has proved deposits of graphite, iron, manganese, tin, lead, molybdenum, magnetite, gold, coal and oil shale, according to reports.

Survey, begun in August 1957 with Russian and Communist Chinese technologists and recently completed, also cited mapping of good agricultural land and vast timber tracts.

Western Governors Offer Resolutions for Mines

FEDERAL AID to domestic miners was called for by the eleven Governors of the Western states at a meeting at Colorado Springs. Unanimous approval was given to the following points:

Early and favorable action on tariff relief applications for copper, lead and zinc, and similar consideration for tungsten and mercury; import controls to protect cobalt, tungsten, mercury, fluorspar, columbium and possibly manganese; use of import receipts to maintain a "minimum nucleus of production" in antimony, chrome, asbestos, and possibly manganese;

A purchase program (by AEC) for thorium or release of thorium from Government control and cessation of purchase of foreign monozite "at the expense of closing domestic mines";

AEC refrain from purchasing high cost foreign production while limiting production domestically; that Government provide adequate purchasing depots and milling facilities, located sufficiently close to ore reserves and stockpiles in order that excessive transportation costs now paid by the Government and the producers be obviated;

"Grant to U. S. citizens the same right to own gold as granted to foreign governments," and increase the depletion rate from 15- to 23%.

The Governors also asked for early adoption of a national minerals policy and for Federal action to insure domestic producers at least half of the domestic market or their present proportion of the market, if it is greater than half.

American Chrome Starts Plans for Pilot Plant

A PILOT PLANT project that may lead to the first self-sustaining commercial ferrochrome operation in the U. S. has been announced by the American Chrome Co., San Francisco.

LIDDICOAT

. . . the tungsten carbide bit that needs no resharpening

SPECIAL LONG LIFE INSERTS...FAST CUTTING ACTION

PATENTS APPLIED FOR

The exclusive shallow long life inserts need no resharpening because they do not develop a reverse taper dullness . . . a condition that stops drilling in the conventional multi-use bit. The exclusive design of LIDDICOAT permits fast drilling far beyond the point where conventional multi-use carbide bits must be withdrawn from service for resharpening. Fast drilling continues during the entire bit usage without need of resharpening. Lower first cost – low cost per foot of hole drilled.

Taper socket — No threads — Fast, firm attachment

The type TS Tee Cee Liddicoat (no resharpening) bit has a completely new short taper socket connection. Within the socket of the bit is a brass shim. The socket, which is completely forged, is tapered to correspond to the taper placed on the drill rod. The connection assures an absolute attachment to the rod, and yet permits easy removal.

FOR ALL SIZES OF DRILL ROD — 7/8" TO 1½"
FORGED FOR TOUGHNESS FROM NICKEL ALLOY STEEL

WESTERN Rock Bit Manufacturing Company

552 West 7th South • Salt Lake City 1 Utah

Chrome Pilot Plant *(Continued)*

The firm has started construction of a $500,000 plant at its chromite properties at Stillwater County, Mont., where reserves are estimated at some 5-million tons.

If commercial production of ferrochrome appears feasible, the company says, a 125-tpd plant will be constructed later, probably timed for start-up in 1960. American Chrome is preparing for the day when it no longer will have a guaranteed market for chromite, as provided for by its GSA contract for 900,000 tons of chrome concentrates. Firm is shipping about 114,000 tons annually and foresees the last shipment in 1960. It hopes ferrochrome will provide a more salable product than chrome concentrate.

Pilot plant, to be in operation by October, will produce high carbon ferrochrome at 5 tpd initially, later at 15 tpd.

VCA Signs AEC Contract Calling for Lower Prices

A CONTRACT covering sales of uranium concentrates processed at the Vanadium Corporation of America's plant at Durango, Colo. has been signed with the AEC at what the company describes as "generally lower prices."

W. C. Keeley, president, announced the contract signing and noted that VCA is consolidating the Naturita operations with those at Durango and enlarging the latter. An ore buying station will be maintained at Naturita. New process changes are expected to yield improved recoveries, Keely said.

DMEA Halts Tungsten Aid

FINANCING of exploration contracts for tungsten has been ordered stopped by the House Appropriations Committee. The committee, said the report, "sees absolutely no justification for additional expenditures of Federal funds for this purpose and directs that no additional tungsten contracts be approved."

New Assessment Rule Is Requested by Senators

OWNERS OF MINING CLAIMS will be absolved for one year from performing $100 worth of labor manually on claims if a bill introduced by Senators Bible, Murray and Church passes the Congress.

The bill, offered to aid small miners in the current critical period, would require claimants to file notice of intention to hold the claims, and eliminate the $100 labor requirement for one year only.

Vermont Copper Mine Ends a Long History

ONE OF THE NATION'S OLDEST copper mines—the Elizabeth mine (Vt.)—is closing down. The property was first worked by a group of farmers in 1793 and is now officially listed as exhausted.

A $2.5-million plant, owned by Appalachian Sulphides, Inc. will be dismantled and shipped to company operations in North Carolina. At peak post-WWII production, the mine produced more than 300,000 tons of ore annually.

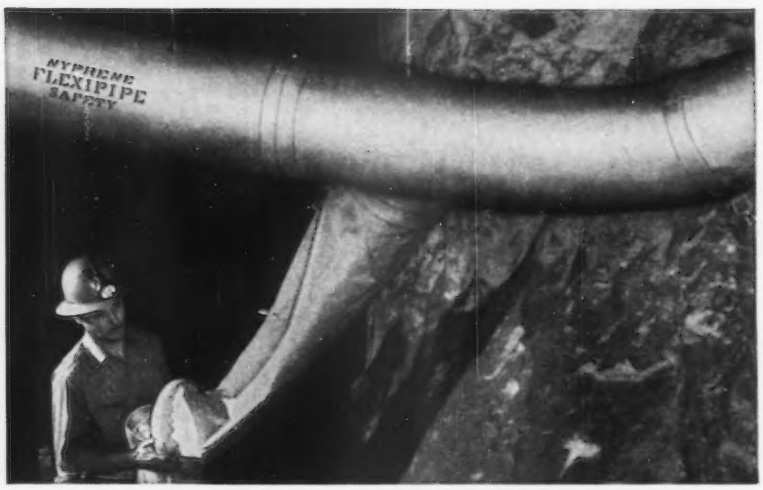
Nickel Forecast

(Continued from p 108)

is believed that financial executives would prefer to base their bond redemption on a mean, or average trend, similar to Curve G.

Imponderables: In dealing with any forecast for nickel, we should not lose sight of the fact that there are forces at work that may seriously affect future production. The fact that nickel is a comparatively youthful and vigorous metal, for which continuing intensive research has been widening its field of usefulness, makes it reasonable to suppose that successful research will continue to exert an ex-

THE BIGGEST NEWS IN MINE VENTILATION TUBING . . .



BEMIS SAFETY YELLOW NYPRENE

FLEXIPIPE®

SAFETY YELLOW means just that . . . SAFETY! The yellow Nyprene material reflects light and is readily visible in darkness. It minimizes damage from punctures by machinery and equipment.

Then add these six other major benefits and you'll see why Bemis SAFETY YELLOW Nyprene FLEXIPIPE is your best ventilation value . . .

- Featherweight—fast, easy handling saves labor costs.
- Resistant to acid mine water, oil, grease, abrasion.
- Mildew-proof—will not rot even if stored wet.
- Stores compactly—requires small warehouse space.
- Tremendous tear and tensile strength.
- Long life, low cost, minimum maintenance.

Bemis also manufactures durable, economical Jute-grade FLEXIPIPE. Both types (Jute-grade and Safety Yellow) are available with Bemis Rope Seam Suspension at no extra cost.

Write or wire for complete information about Bemis FLEXIPIPE

Bemis BEMIS BAG CO.

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Look ahead...*move ahead*...and stay ahead

with ALLIS-CHALMERS

the fastest-growing name in motor scrapers

In 1957, earth movers the world over bought more Allis-Chalmers motor scrapers than ever before! This growing popularity is the best proof of the productivity and reliability of this outstanding line. There are good reasons for this trend toward Allis-Chalmers construction machinery . . . investigate these advantages before you buy.

Three models to help you match your job needs.....

TS-360 Fastest-loading big machine in the business... 280 hp moves 20 yd loads at high speed.

the only line with all these basic

TS-260 A new measure of performance in this size range... 200 hp ... 14 yd... full 90-degree turning.

TS-160 True versatility and economy in a utility machine... 155 hp... 9½ yd... turns non-stop in less than 25 ft.

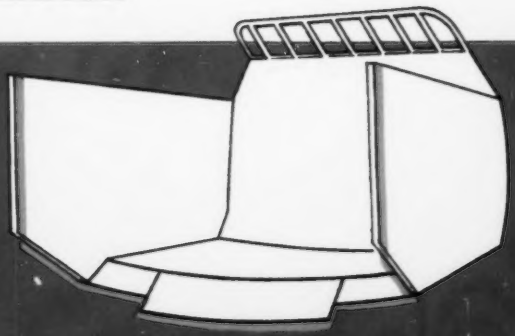
advantages in every size...

- high power-to-yardage ratio
- low, wide bowl
- positive forced ejection
- high apron lift

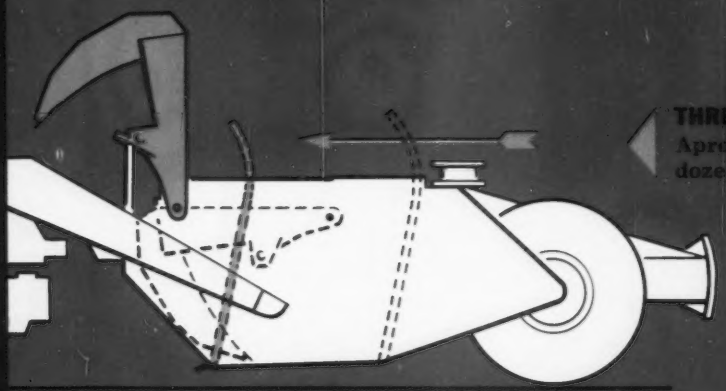
on the big jobs... or for utility work

See these big advantages of Allis-Chalmers motor scrapers

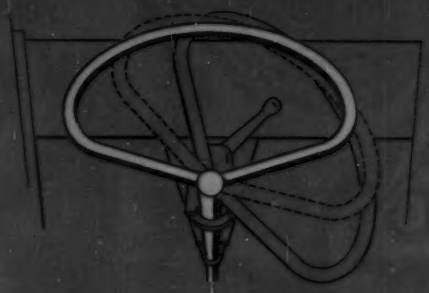
...IN A WORKING DEMONSTRATION



LOW, WIDE BOWL... Loads full—fast—with low resistance, live action.



THREE-POINT APRON-EJECTOR LINKAGE—Apron opens high as the positive ejector dozes out the load . . . clean and quick.



SELECTIVE HYDRAULIC STEERING—Accurate, sure control at any speed . . . fast, full-swing steering with a 30-degree turn of steering wheel right or left.

A DEMONSTRATION WILL PROVE IT—

Your Allis-Chalmers dealer will be glad to arrange a demonstration to show you these machines in action. When you've seen and tried these high-performance motor scrapers, you'll know why more dirt movers every day . . .

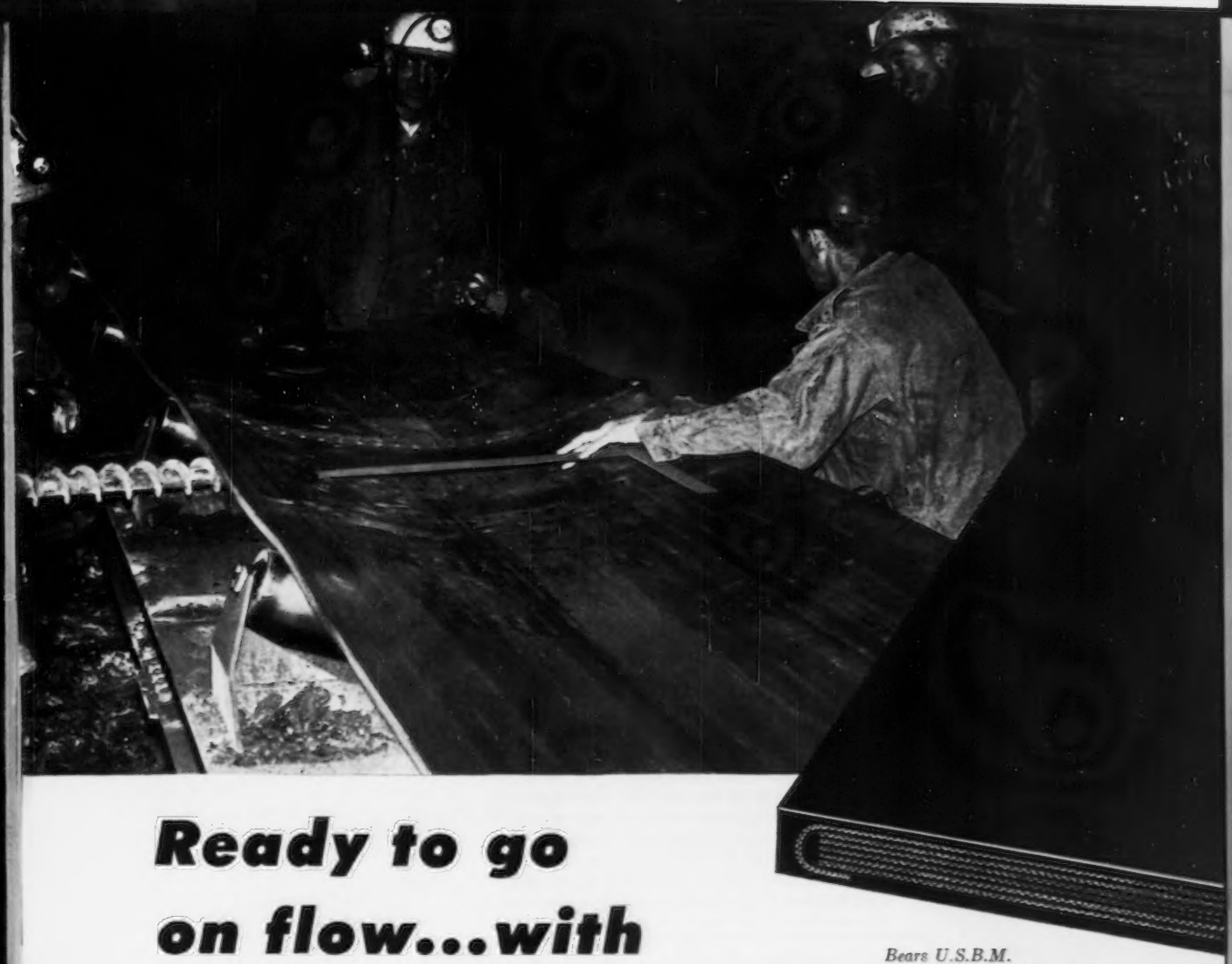
Look ahead...*move ahead*...and stay ahead

ALLIS-CHALMERS CONSTRUCTION MACHINERY DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

FORM MS 1298-584

Litho in U. S. A.



Ready to go on flow...with Thermocoal Belting

Bears U.S.B.M. acceptance designation #28-13.

Tough . . . fire-resistant . . . long-wearing, Thermocoal conveyor belting is used by profit-minded mine operators everywhere.

Here's belting that bears acceptance designation #28-13 of the U. S. Bureau of Mines . . . meets or exceeds all after-flame and after-glow tests. It's rugged belting, with high resistance to flexing and impact, edge wear, abrasion and mildew.

Specify construction of cotton, cotton-nylon or rayon duck. All are impregnated with specially compounded Thermoid rubber stocks for long, economical service.

Order Thermocoal Belting through your Thermoid distributor, or write direct for detailed information and data sheets.

Cut costs with Thermoid Multi V-Belts . . .

. . . and Thermoid Hose

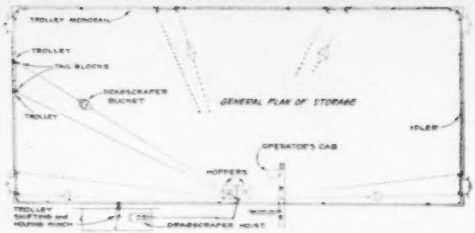
Thermoid

Thermoid Company
Trenton, New Jersey
Nephi, Utah

Three Sauerman Methods for Cutting Storage and Reclamation Costs

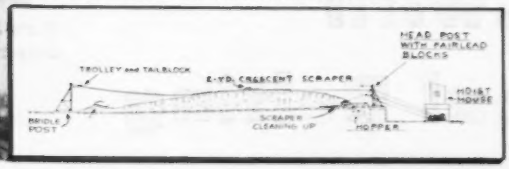
INDOOR RECLAMATION

DragScraper with Trolley and Monorail—Material dropped onto stockpiles from an overhead conveyor is reclaimed to hoppers by a 2½-cu. yd. DragScraper. The installation uses a monorail and trolley system to permit shifting of the scraper bucket by remote control from operator's station at right.—*Sauerman News No. 143.*



OPEN STORAGE

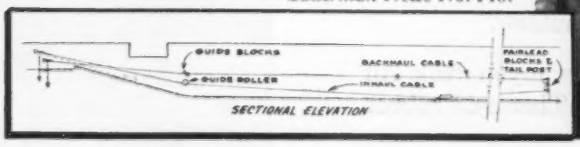
DragScraper with Trolley and Elevated Bridle—DragScraper is reclaiming raw potash to hopper from storage pile. Material is dumped at rear of the pile and moved closer to hopper during intervals when mill requirements are satisfied. Trolley and tail block travel on an elevated bridle between two stiff-leg bridle posts. Shifting of the trolley is provided by a third drum on the Sauerman DragScraper Hoist—*Sauerman News No. 146.*



HANDLING HOT MATERIAL

DragScraper—Hot scale is dropped from ingot buggy track into tunnel and is conveyed by DragScraper to a water sluiceway for disposal. Safety is important here—personnel and vulnerable equipment do not enter the hazardous area.

—*Sauerman News No. 146.*



Find out what the Sauerman Method can do for you

Give us details on your operation. Our engineers will give prompt recommendations and work with you to provide the best method for your requirements. Ask for Catalogs A (DragScrapers) and E (Bulk Storage by DragScraper).

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Crescent Scrapers • Slackline and Tautline Cableways • Durolite Blocks

Nickel *(Continued)*

panding influence which could raise total Free World production to well above the 602,200 net tons shown on Curve G for 1980.

However, it should also be recognized that in the past, up to three quarters of the nickel produced has gone into armaments. If this trend persists to 1980, then Curve G should remain valid. On the other hand, guided missiles with atomic or hydrogen war heads, may render our existing types of armaments largely obsolete, thereby creating a serious void in future demand. Carrying this thought a step further it would appear that should the nations finally achieve world disarmament, a very drastic reduction in demand for nickel would ensue that might take a long time to overcome. In short, the considerations above noted all hinge upon the generally unpredictable nature of international politics.

And finally, it must be realized that no forecasts of any sort would be worth the reading should World War III break out.

Acknowledgements: I wish to express my appreciation of the many useful comments and suggestions received at various times in the preparation of this and other forecasts, from the late James D. McClintock of the Ventures, Ltd. organization, from Prof. A. P. Hillman, while Professor of Mathematics at Columbia University and from Mr. Anton Gronningsater, consulting metallurgist to Ventures, Ltd.

In The U.S.

ALASKA

Territory Department of Mines has announced opposition to the 9-million acre conservation withdrawal in northeastern Alaska. TDM points out that, contrary to the early impression that mineral entry would be permitted, it appears entry will more likely be prohibited, except possibly under a permit system. A public hearing was to be held if the withdrawal was protested by March 14.

ARIZONA

Low copper prices have caused a 390-man layoff at Miami Copper Co., Miami, Ariz. And the International Smelting & Refining Co. at Miami announced it would cut back to a 4-day week because of reduced tonnage.

Vance Coil, mine superintendent, said the production cutback will reduce ore operations by 6,000 tpd and copper production by 698 tpm.

long-run power by Allis-Chalmers

NOW... tube-type MOTORS with capsule-mounted split-sleeve bearings

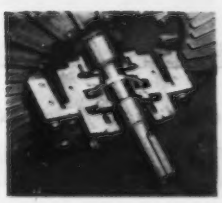
Now the most effective air cooling system ever designed for larger TEFC motors has been combined with the accessibility of capsule-mounted split-sleeve bearings. *Both* of these user benefits are available in a newly designed line of Allis-Chalmers tube-type motors.

Indoors or outdoors, these Allis-Chalmers motors are ideal for moist, corrosive and hazardous atmospheres. Contact your A-C district office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

Cooling system works like this: Air circulated within the motor by internal fans transfers motor heat to a nest of tubes around the stator. External fans constantly blow cool air through the tubes to absorb and remove heat.

ALLIS-CHALMERS

A-5580



Capsule mountings permit access to bearings without exposing vital electrical parts. This design is available for directly coupled drives; ball or roller bearings also available.

Here is the Proved Way to Concentrate Minerals Efficiently

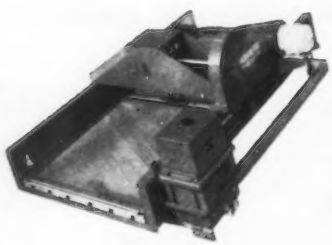
For more than four decades, the SuperDuty® DIAGONAL-DECK® Concentrating Table has been producing high grade concentrates at lower cost than is possible by any other comparable method.

The reason for this is found in a correct coordination of all tabling factors. Even the shape of the deck conforms to the natural path of material flow, eliminating non-producing dead areas and utilizing riffle functions to the utmost. The result is higher grade concentrates, minimum loss to the tailings and a greatly reduced middling load for recirculation, making room for more tons of new feed per day and cutting maintenance costs.

These results are proved. Send for complete data and Bulletin 118-B.

FOR SCREENING ECONOMY

All New Model Leahy® screens utilize proven differential vibration that snaps oversize wedging particles loose 1600 times per minute. When dust is a problem, totally enclosed models are available. For damp screening, Flex-Elex® electric heating of the screen jacket insures full-time open mesh. For wet screening CONCENCO® spray nozzle arrangements are available.



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CONCENTRATOR
COMPANY
903 Glasgow Ave. • Fort Wayne, Ind., U.S.A.
CONCENCO PRODUCTS

★ *The ORIGINAL Deister Company* ★ *Inc. 1906*

Arizona *(Continued)*

Cutback is in the company's underground division. No change in operations is planned at the Copper Cities and Castle Dome divisions.

Kennecott's Ray Division will increase copper recovery by 12% with installation of the leach-precipitate-float process for oxide ores. Results from use of the LPF system (which is still being modified) indicate additional recovery of two pounds of copper per ton of ore.

Capacity expansion to 20,000 tons annual output involve enlarging the pit and relocating surface facilities; expanding mill capacity. Construction of a smelter is also scheduled.

ALABAMA

General Graphite Co. has blocked out more than 15-million tons of graphite ore averaging about 4%. Company also owns the Alabama Flake Graphite Co. which holds a 200-tpd mill. Mill has been leased to Industrial Minerals Corp. who will increase capacity to 600 tpd.

CALIFORNIA

In the last eight months, sales to shoestring operators looking for gold have zoomed 30%, one Bakersfield equipment firm reports. Other dealers, speculators and mine operators confirm local reports that a great movement-to-the-gold-hills has been touched off by the current economic recession.

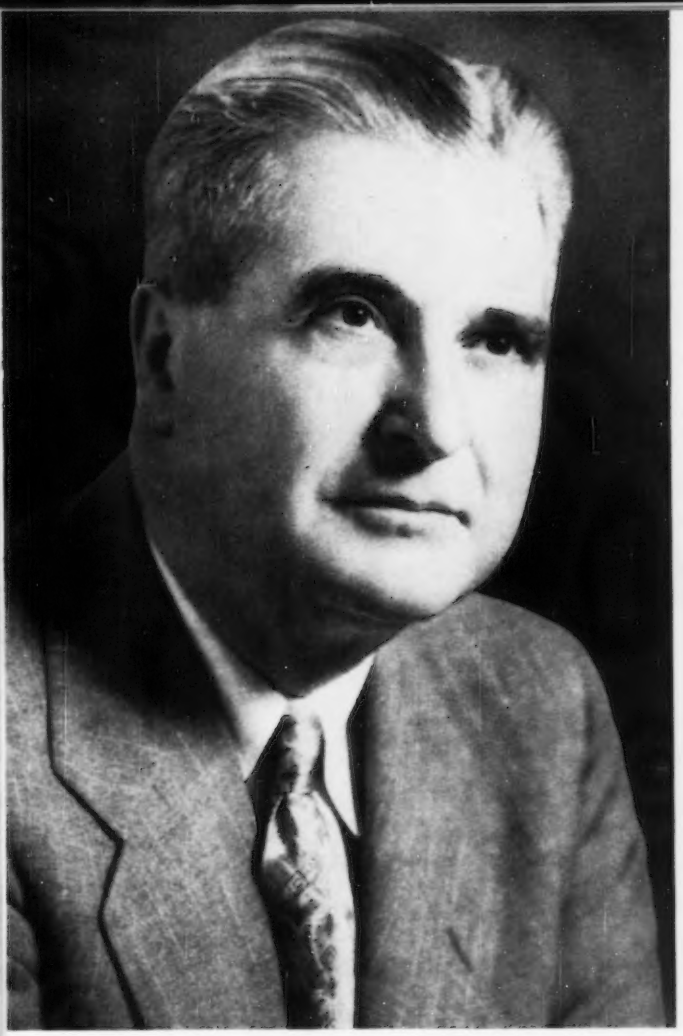
Equipment being purchased is mostly secondhand and to be operated by single prospectors or prospectors working in tandem.

Many of the new miners are weekenders trying to augment the family income. Others are men thrown out of work when Kern County's uranium and tungsten operations folded less than a year ago.

Lease speculators are buying up claims at an unprecedented rate. One operator reports he has tied up three properties in recent months and is going after others.

Miners and speculators have one great hope, that the Government will boost the price of gold up to $50 or even $60. Many people feel there is reason to nurse such a hope. "We are getting help from Western senators, more now than ever in the past," one property-leaser comments. On one hand the tremendous upsurge in gold interest in Kern County has made it increasingly difficult to tie up property, but on the other hand, "the more people interested, the better our chances in Washington."

Machines to upgrade ore are the topics of frequent newspaper stories, and a Kern County mining association has been formed to help along with favorable legislation. Meanwhile, sales of picks, pans, compressors, jack hammers and portable dredges is brisk. And a man who is willing to work hard can make what one dealer calls "truly excellent wages."



"Because of outstanding performance," says **J. B. Rich,** *Pres.—*

"Gilberton Coal's electric-powered excavators use General Electric systems–exclusively"

"One shovel has operated 6000 hours with only routine maintenance"

Gilberton Coal Company is a fast growing firm mining a rich anthracite coal vein in eastern Pennsylvania. Because Gilberton has received dependable, continuous operations from General Electric equipped shovels and draglines, all their electric-powered excavators now utilize G-E motors and control.

General Electric Engineers work closely with shovel and dragline manufacturers to carefully match all characteristics of electrical amplidyne control, motors, and generators with those of the shovel or dragline. This co-ordinated electrical-mechanical design results in rugged, rapidly responding machines like those setting performance records at Gilberton Coal Co.

What's more, in quarry and mining areas throughout the nation, you will find G-E renewal parts distributors and complete, efficient, around-the-clock service from near-by General Electric Service Shops.

When You Plan to purchase an electrical excavator for your mining operations, specify a machine powered and controlled by General Electric system-engineered equipment. Write Section 663-49, General Electric Co., Schenectady, N. Y.

Engineered Electrical Systems for the Mining Industry

GENERAL ELECTRIC

32-YD WALKING DRAGLINE takes a 50-ton bite of overburden, dumps it, and swings back for another—*every 50 seconds.* Tremendous power (4950 hp) and precisely responding controls regulate this performance. Heart of the G-E electrical system in this Bucyrus-Erie dragline is the 1500-hp synchronous motor and 600-hp induction motor driving generators which feed d-c power to drag, hoist, swing and walking motors. The dragline operates 130 hours per week, year 'round.

EXIDE-IRONCLAD BATTERIES

—best buy for the long haul

More ton-miles per dollar—that's the reason most cost-conscious mine operators prefer Exide-Ironclad Batteries for mine locomotives.

Experience has proved over the years that no other battery make matches Exide-Ironclad for average life in service and tonnage hauled. Rating for rating and dollar for dollar, Exide-Ironclad gives you more real value . . . more return on your investment.

Today's Exide-Ironclad features improved tubular construction, making it even better than the models that chalked up the industry's records. So you can expect even longer life potential and superior performance.

Total work output, not mere price, is the key to battery economy. When you buy batteries, specify Exide-Ironclad and get the most production capacity your dollar can buy. For details, write Exide Industrial Division, The Electric Storage Battery Company, Philadelphia 2, Pa.

High-capacity, long-life tubular construction. Gives positive plate one-third more surface area for greater power reserve. Power tubes hold active material securely for long battery life.

Exide®

California *(Continued)*

WORKING FOR HIMSELF. Thrown out of work when the tungsten mines closed, Richard Bright mines gold ore at the Yellow Aster diggings at Randsburg. He says that the ore brings $40 a ton and that he can shovel three tons a day. His equipment is simple, a pick and shovel, an ore chute leading to a wheelbarrow—and a pick-up truck. He points to the glory hole of the Yellow Aster mine. There's a 3-in. vein of almost pure gold nearby. The only trouble is that the vein is in an area condemned by the Government as too dangerous for mining. Some years ago two miners tried to mine the vein and were killed in a slide.

COLORADO

Activity in the Rio Grande County district continues to receive a substantial exploration and development program from General Minerals Corp. Over 5,000-ft of tunnels were rehabilitated on the Reynolds, Chandler, Dexter and Iowa levels, and 3,000-ft of diamond drilling completed in the Annie and Tewksbury Vein areas.

A contract with DMEA for $149,380 for continued exploration of copper and lead was signed. S. Y. Guthrie, Dallas, Texas, is president of General Minerals Corp.

Pinnacle Exploration Inc., the operating company for all Callahan Zinc-Lead Co. and Vulcan Silver Lead Corp. operations in Colorado, continued exploration for uranium through 1957 in the Marshall Pass area of Gunnison and Saguache counties, Colorado.

Worcester Mines, a partnership consisting of Grand Junction residents has completed approximately five years of exploration, development and mining on a small AEC lease. Worcester's shaft is located six miles north of Uravan, just below the south rim of Atkinson Mesa in Montrose County.

The gross tons of ore produced, to date, exceeds original estimates, based on limited diamond drill information, by 55% company claims. Mine management consists of Paul R. Martin, foreman; Joe

PRODUCERS

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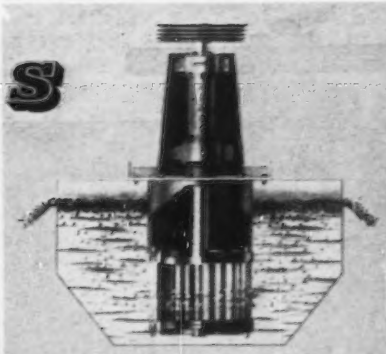
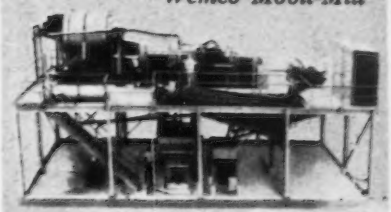
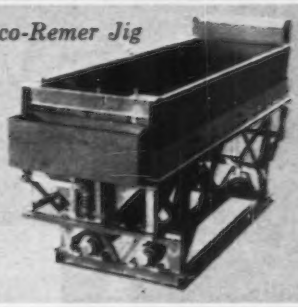


Wemco Fagergren Flotation Machine

Wemco Mobil-Mill



Wemco-Remer Jig



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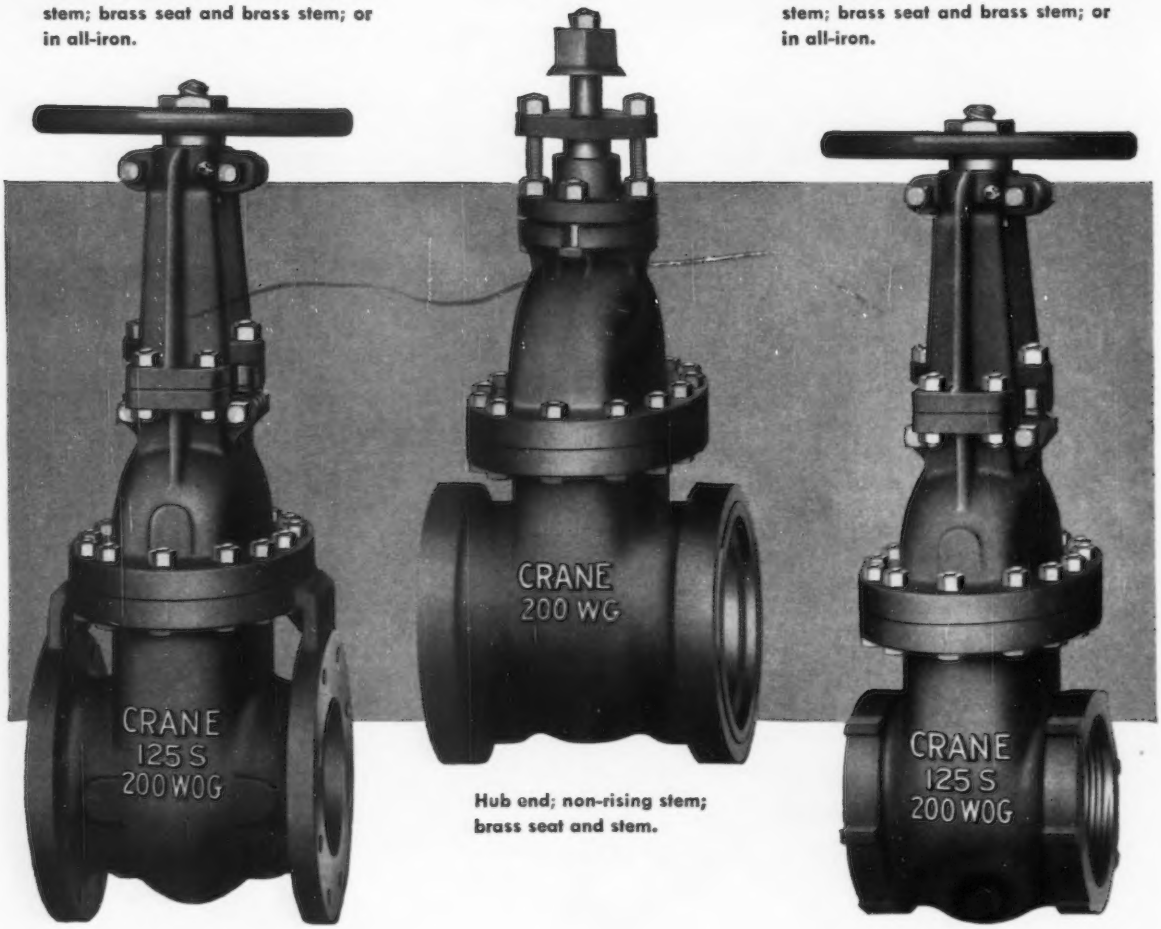
Flanged end; outside screw and yoke. Available with brass seat and steel stem; brass seat and brass stem; or in all-iron.

Screwed end; outside screw and yoke. Available with brass seat and steel stem; brass seat and brass stem; or in all-iron.



Hub end; non-rising stem; brass seat and stem.

Crane Iron Body Gates–Versatile Valves for Mining Industry Services

Look to Crane for better performing 125-pound iron body wedge gate valves. Improved design gives them greater strength and important operational advantages. As a result, these valves offer dependable performance on a wide variety of services . . . easy maintenance . . . long life.

Among the advantages of Crane iron body wedge gates are:

- *Oval body and bonnet,* with extra metal where needed most.
- *No bonnet joint leakage*—More bonnet bolts on closer centers insure uniform bolt load distribution on bonnet joint and gasket.
- *Long disc guides* seat discs properly . . . minimize drag on seating surfaces . . . prolong valve life.
- *Shoulder-type seat rings* prevent rings from loosening in service.
- *Two-piece ball-type gland* prevents binding on stem even when gland bolt nuts are pulled up unevenly.
- *Exceptionally deep stuffing box* can easily be repacked under pressure when valves are wide open.
- *Available in 19 sizes*—2 inches to 48 inches—all-iron or brass trimmed. In addition, Crane makes companion valves in globe, angle, check, quick-opening and Underwriters' patterns.

For complete descriptions of Crane iron body gate valves, consult your Crane Representative, or write to Crane Co. at the address shown below.

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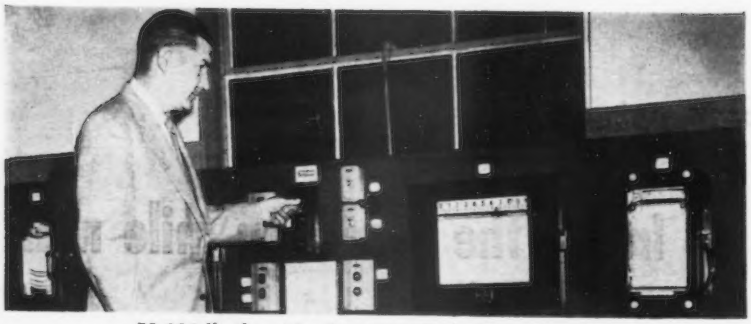

50,000 lb. thrust load torture test for Raynile splice.

The first Raynile Belt installed by Hewitt-Robins in 1948 is still in service, with a record of extreme ruggedness; exceptional resistance to ripping and to impact; and improved troughing and training. This is good reason why these Hewitt-Robins conveyor belts have become the FAMOUS NAMES ON THE BIG JOBS EVERYWHERE for handling all kinds of bulk materials:

RAYNILE; for operating tensions of 90 to 130 lbs. per inch per ply.

SUPER RAYNILE; for operating tensions of 150 to 200 lbs. per inch per ply, improved with miracle fabric to do jobs previously thought impossible.

RAYNILE SUPREME; with miracle fiber for tensions over 200 lbs., stronger and more flexible than steel.

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Colorado *(Continued)*

G. Steckler, shift boss, and John W. Hill, managing partner.

In 1957, the Empire Zinc division, New Jersey Zinc Co. at Gilman, continued operations on a full production, three-shift basis despite the fall in zinc prices.

Approximately 4,400 tpm of zinc concentrates were produced. About 700 tons of lead concentrates and 1,700 to 1,900 tons of copper-silver ores were shipped to smelters monthly.

News of a rich strike on the El Paso mine at Cripple Creek has been measured by Earl Robush, El Paso superintendent. The strike, on the third level, has been assayed at from four to 17 oz. gold in grab samples with the "hot stuff" from the streak valued at nearly $100 per lb. Several tons of this ore have already been shipped to the Carlton Mill.

The rich strike has so far shown itself in a streak about an inch wide running across a 25 ft stope with ore values up to 17 oz. At the present time, stoping operations are in progress with about 30 tons being shipped weekly. Owner of the El Paso is the Beacon Hill Mining Co., headed by J. Selby Young of Colorado Springs. El Paso mine is credited with a past production of $10-million.

In Clear Creek county, mines that were worked part time during the past year include the Headlight, Donaldson, Edgar, Grizzly mine & mill, Jo Reynolds, Johnny Bull, Last Chance, New Century, Lead Belt and Columbian Chief.

Mohawk Mine was operated by Norman Miner part time during the year and a new compressor-house and compressor were installed. Miner has worked on this property for several years and states that he is just now getting it in shape for producing ore some time later in 1958.

Construction work on the Cotter Corp. mill at Canon City may be started during the month with completion well inside the current year, it was stated by Dave Marcott, vice president and plant manager. Marcott said he had received word that AEC might render a decision shortly on the revised application of Cotter for a larger mill. AEC already has approved the Cotter application for a 100-ton mill.

Cotter Corp. has contracted with Western Knapp Engineering Co. and indicates that construction may be completed within eight months from the starting date.

American Beryl Corp., which owns beryl ore deposits in the Crystal Mount area west of Ft. Collins is completing its new mill there. The mill will produce concentrated beryl ore. Colorado School of Mines specialists have worked out a process for use in the mill. American Beryl is headed by John Banks of Ft. Collins.

Mountain Dale Mining Co.'s Boomer mine, Park County, shipped over 200 tons of high grade beryl during 1957, according to Verl Bratton, president of the company. Bratton states production

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for the Mining Industry

Dependable operation in wet or dry grinding of material at low cost, with minimum maintenance—this is the reputation that KENNEDY Rod Mills enjoy.

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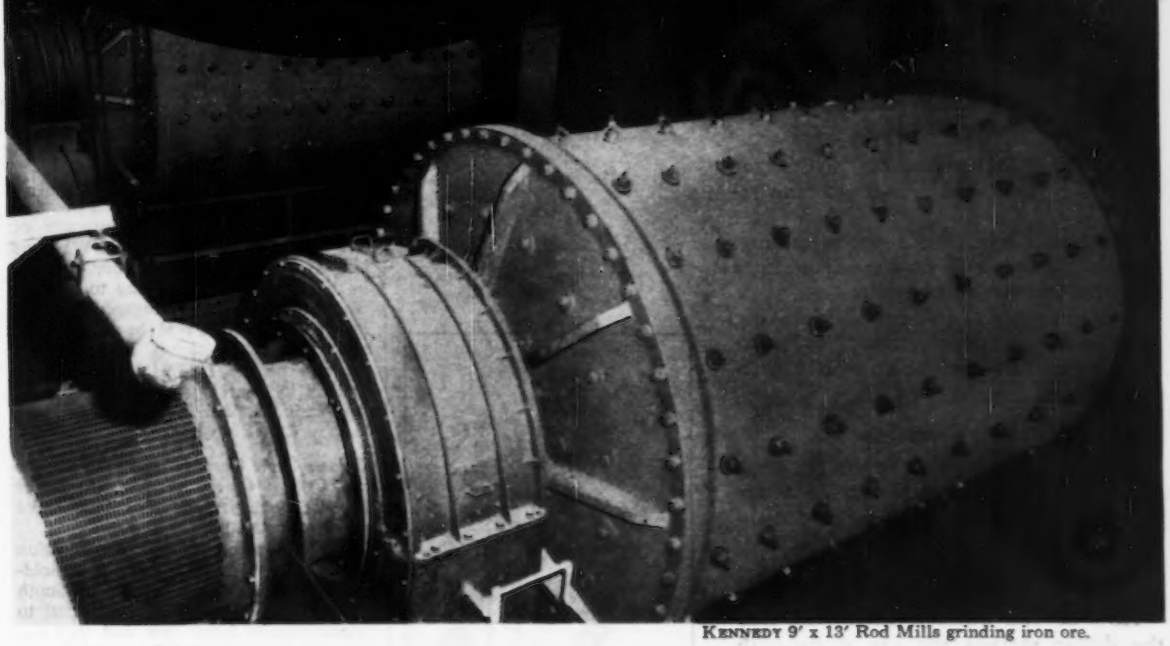

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Handle tough fluid mixing jobs...

without costly maintenance

Why you'll never have to replace a gear because of shock loads on this mixer

Here's one mixer you *won't* have to tear down for expensive, time-consuming repairs.

No matter what fluids you're mixing, normal shock loads on the mixer shaft can't damage the gears—ever.

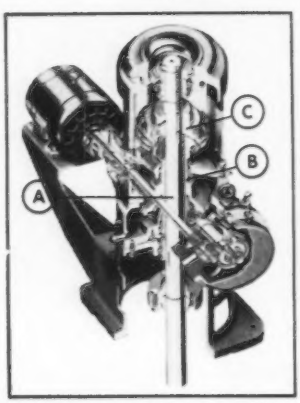
You get years of low-cost fluid mixing because of this "flex-protected" construction. It's exclusive with Series "E" LIGHTNIN Mixers.

Results guaranteed

You can meet the toughest fluid mixing requirements with LIGHTNINS. There are hundreds of standard power-speed combinations, in sizes from 1 to 500 HP.

Mixing results are fully predictable—unconditionally guaranteed.

How do you translate these facts into the dollar savings *you* can make with LIGHTNINS? For details, just call your nearest LIGHTNIN Mixer representative (listed in Thomas' Register). Or write us direct for complete description of Series "E" LIGHTNIN Mixers. Just ask for Catalog B-102.



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The mixer shaft (A) passes through a drive quill (B). Shaft and quill are suspended on separate sets of heavy-duty bearings. Power is transmitted from quill to shaft through a flexible coupling (C). This coupling accommodates shaft flexures, soaks up shock loads, and *isolates shaft stresses from the gearing.*

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Colorado *(Continued)*

of quality ore continues at a good rate, with more than 70 tons shipped during February.

Annual report to the stockholders of Front Range Mines Inc. by John Deerksen, president, says that "in spite of the ever-increasing hardships laid in the way of the domestic mine operator and the gold miner in particular, we managed to get through the year with a comparatively small loss when we consider that over $50,000 was spent in development work on Strong mine at Cripple Creek and the uranium property, and for additional new machinery and equipment at the mine and mill.

Total gross shipments amounted to $229,302.98 of which 2100-ft level (2600) Ajax produced $126,388.57 with an average value of $47.85 per ton, and 1900 produced $102,914.41 with an average value of $37.05 per ton—not nearly as good an average as the previous year but still much better than most, if not all, of the few remaining gold producers in the country.

United Western Minerals of Santa Fe, N. M. is surveying and drilling land in the Tallahassee district northwest of Canon City. Marvin Chas, manager of the Canon City office, says UWM has claims or leases on about 150,000 acres in the area from Tallahassee to Hartsel, where the company is engaged in uranium exploration. UWM has staked approximately 2,500 claims. The large area includes private land, state leases and Federal lode mining claims. Other holdings include about 13,000 acres in the Sangre De Cristo range.

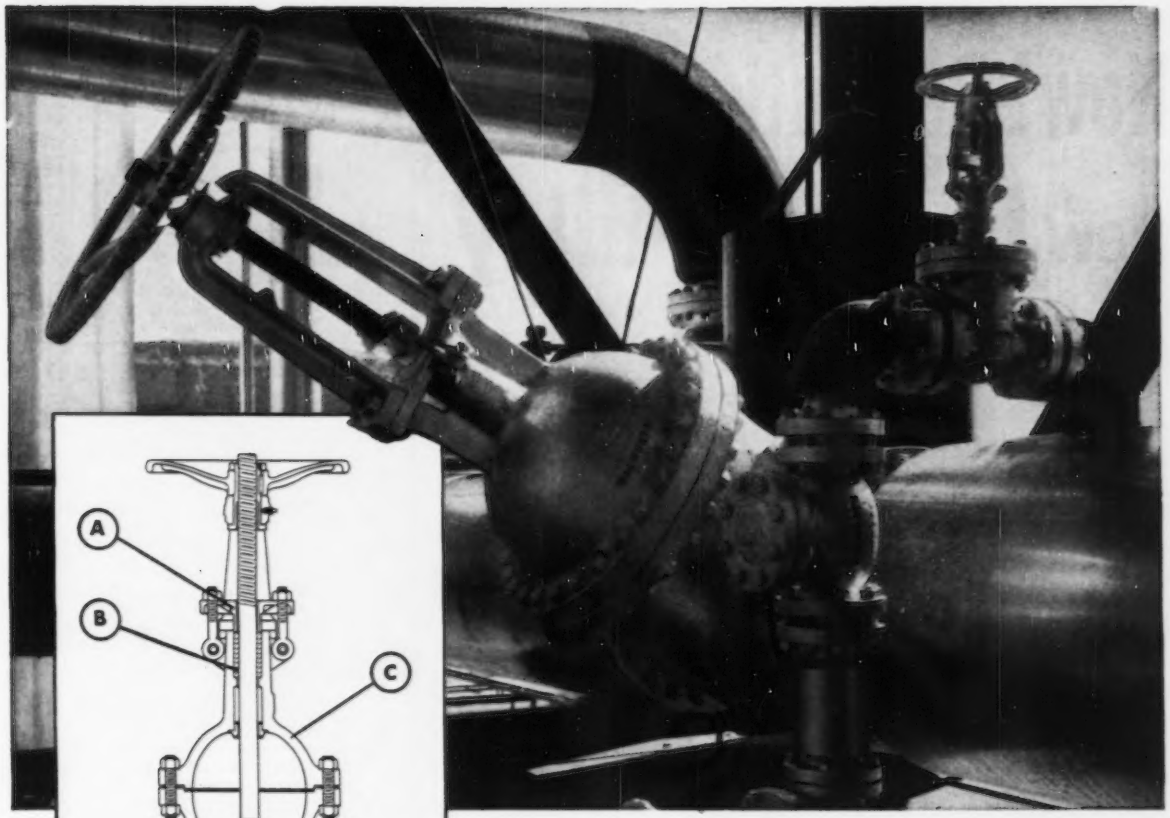
Golden Cycle Corp. of Colorado Springs and Cripple Creek, has issued a report to stockholders following its annual meeting Jan. 30.

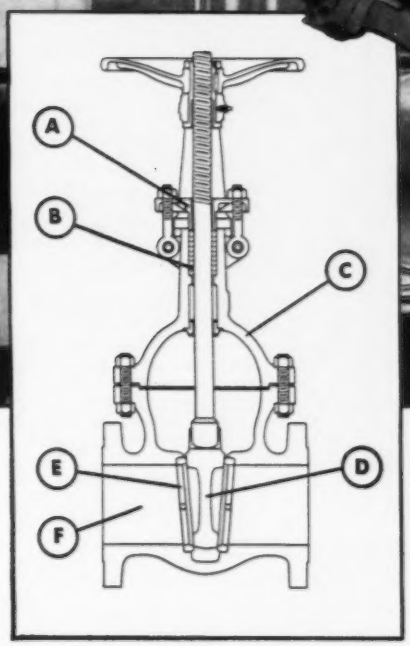
Report shows that uranium production resulting from its 50% interest in holdings in the Black Hills area of South Dakota and Wyoming has increased to approximately 5,000 tpm and that ore reserves have increased materially as the result of a large amount of exploration drilling.

While the AEC caused uranium production from the company's Black Bear operation near Marysvale, Utah, to be reduced from 500 tons to 300 tpm, it is prepared to extend production when permission is received from the AEC.

The company's suit against the Government for damages of approximately $2-million, as a result of the War Production order of 1942 for the closure of gold mines, is being held in abeyance until the settlement of the Homestake damage suit in the Supreme Court, which is expected by or before the middle of June.

Big Horn Uranium & Oil, Inc. has acquired a substantial number of shares of the stock of Gold Hill Mines Co. Pitkin County, with the expectation of merging the two companies. Shares of Gold Hill Mines Co. are being exchanged for those of Big Horn of equal value share for share. It's the intention of Big Horn to put the Independence Tunnel





Walworth Series 150 and 300

CAST STEEL GATE VALVES OFFER YOU THESE FEATURES

for 'round-the-plant service

(A) GLANDS: Clearances between the gland and stuffing box, and gland and stem, are such that the stem cannot be scored even if the gland is pulled down unevenly.

(B) DEEP STUFFING BOXES: More than adequate in all sizes (2″ to 24″) to assure tightness and maximum packing life.

(C) BONNETS AND BODIES: Engineered to exceed the requirements of all applicable codes and standards. They are tough, durable, dependable.

(D) INTEGRAL GUIDE RIB FACES IN BODY: Machined to insure accurate centering of the gate.

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(F) STREAMLINED PORTS: Permit unobstructed flow which results in minimum pressure drop and reduces the possibility of erosion.

Walworth Cast Steel Gate Valves can be furnished with either flanged ends or butt welding ends. Roller bearing yokes are available on the larger sizes. On valves 4 inches and larger, by-passes can be furnished. Walworth Cast Steel Gate, Globe and Check Valves from Series 150 to 2500, are available. For Series 600 and higher, we recommend Walworth Pressure Seal Cast Steel Valves. See your Walworth Distributor or write to Walworth for complete information.

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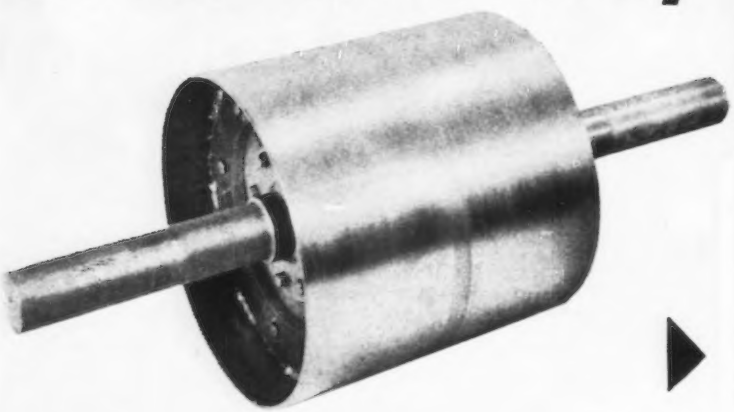

- Outperforms conventional permanent magnet pulleys
- Equals deep-field power of electromagnetic types,

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- costs nothing to operate
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- eliminates rectifier
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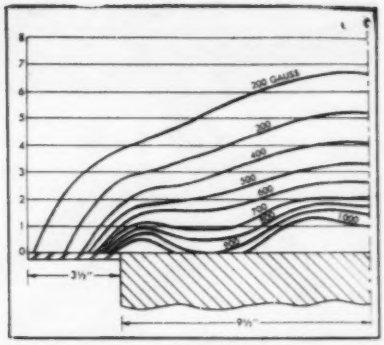
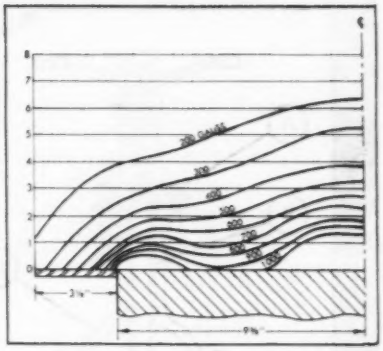
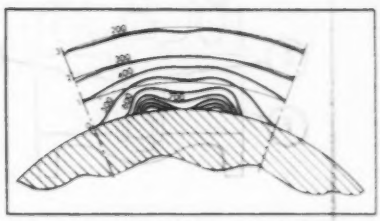


GAUSS PATTERN: SIZE 18 × 24 ELECTRO MAGNETIC PULLEY AT 80% OF RATED CURRENT



GAUSS PATTERN: SIZE 18 X 24 INDOX V PERMANENT MAGNETIC PULLEY



GAUSS PATTERN: SIZE 18 X 24 ALNICO V PERMANENT MAGNETIC PULLEY

Never before could you expect tramp iron protection like this with a permanent magnet pulley! Performance of the new Stearns Indox V pulley is equal to that of electromagnetic types—yet it has all the cost-saving advantages of permanent magnet design

Indox V is the amazing *ceramic* magnet material used exclusively in Stearns pulleys. It is the heart of an entirely new magnet assembly with *radial pole design*. This feature produces a strong magnetic field that blankets the conveyor burden, pulls out troublesome tramp iron far more efficiently than old-style permanent magnet pulleys.

The Indox V pulley needs no energizing current. It costs nothing to operate, requires no maintenance, ignores power failures.

Stearns Series "410" Permanent Magnet Pulleys — and Stearns "710" for deeper conveyor burdens — are available in standard widths from 12 to 48 inches, and in diameters of 12, 15, 18, 20 and 24 inches. Stearns engineers will help you select the right Indox V Permanent Magnet Pulley to match your conveyor system. Call your Stearns representative, or write for free literature.

*Patents Pending

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The 2½-yd. Lorain-85A Shovel has two vitally important features—available on no other make of shovel—that will send any operator's production figures soaring, with less effort, less fatigue, easier, smoother. They are:

"JOY-STICK" AIR CONTROLS

These 2 levers, through metering valves that retain the old-time normal "feel" of the machine, control all turntable operations through air power. There are fewer levers—fewer motions. Just think what this ease and simplicity of operation means in increased production. Full "Air-Ease" Power Control of crawler travel, steering and tread-travel lock also are provided.

"SHEAR-BALL" MOUNTING

Like a huge, sealed "ball bearing," this revolutionary turntable mounting eliminates forever all adjustment, maintenance and lubrication problems of old-fashioned center pin and roller designs . . . means still more time-saving on the job, more production. Field tested for more than 7 years, the Lorain "Shear-Ball" is real "reliability" in action.

There are many other Lorain-85A features you'll want to know about. Your nearby Thew-Lorain Distributor can tell them to you. And ask him about the on-the-spot Lorain parts and service facilities that are such an important plus value when you buy Lorain. See him soon.

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Why is it that wire rope is often severely damaged near one or both ends while the rest of it is perfectly sound? Obviously, you can't afford to discard the whole rope. So, what can you do to correct or compensate for this condition? These and related questions are fully answered in Service Bulletin No. 106, one of a series designed to help users get more efficient, more economical service from wire rope. Copies are sent free. Write H. K. Porter Company, Inc., Leschen Wire Rope Division, 2727 Hamilton Avenue, St. Louis 12, Missouri.

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WIRE ROPE

H. K. PORTER COMPANY, INC.
LESCHEN WIRE ROPE DIVISION

Colorado *(Continued)*

back in shape for operations as a mine, and installing a mill on the premises.

Flexore Inc. is installing facilities for mining what is believed to be an extensive deposit of perlite at a site about a mile from the famous old silver mining town of Silver Cliff. Bill Arnold, local superintendent for Flexore, announces that the mining operation is nearly ready to go into high gear. After preliminary treatment at the plant now being built, the ore will be shipped to the Flexore Inc. plant in Denver where it will be 'popped' and cast into insulating slabs for all types of building construction.

Jackpot Oil Co. of Denver and a group of Southern California businessmen have purchased the controlling interest in the Bald Eagle Mine in Virginia Canyon from D. J. Young, Haven Leavitt and Duane Larson of Idaho Springs, according to Paul R. Clark, now president of Jackpot. Clark says Jackpot reopened the mine Jan. 2 and a raise and winze are now being run on ore.

"This mine has been the largest base-metals producer on the Front Range in recent years, especially 1956 and 1957," said Clark. "It has produced about $500,000 worth of gold, silver, lead and copper in 18 months' operation from over 14,000 tons of ore, with 52% of the income from gold, and ore averaging $34.69 per ton."

FLORIDA

Circuit Judge H. M. Taylor has ruled in Tallahassee that Coastal Petroleum Co. has exclusive rights to all the metallic minerals in its 4.5-million acre lease of submerged lands. The state had contended that the lease covered only oil, gas, sulphur and potash, and will appeal Taylor's decision.

HAWAII

Hawaii's Neighbor Island Development Council, set up by the territorial governor to spur rural development, has placed highest priority on encouragement of a bauxite industry.

Its immediate goal is Congressional passage of legislation to control bauxite mining in the Territory.

The Interior Department recently recommended major changes in bauxite laws proposed last year by the Territorial legislature, apparently feeling the proposals gave too much leeway to the mining companies.

It noted in its report, however, that "preliminary estimates show over 600-million tons of bauxite in Hawaii, over 10 times the total of other known U. S. reserves."

The report continued: "If any important proportion of these deposits can be commercially developed, they would be sufficient to provide raw material for all American needs for bauxite, alumina

Handling WATER and TAILINGS...

It's no problem to move water, air, or tailings with NAYLOR Spiralweld pipe on the job.

The performance of this pipe is as distinctive as its appearance. The spiral lockseam tells you that NAYLOR pipe is light in weight—easier and more economical to handle and install. It means greater strength, ability to absorb shock loads, stresses and strains—extra safety in service.

NAYLOR pipe comes in diameters from 4″ to 30″ and wall thickness from 14 to 8 gauge. Fittings, connections and special fabrications further simplify installation.

Write for Bulletin No. 507.

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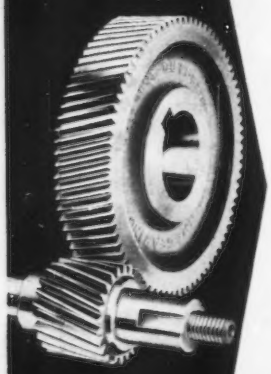
1638 Duti-Rated COMBINATIONS



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*Horsepower Ratings....1 to 200**
*Center Distances.....2" to 12"**

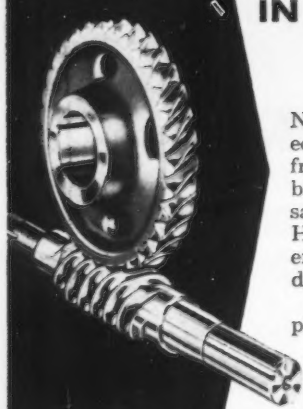
Check with Foote Bros. *before* you finalize that design. The chances are you'll find exactly what you need among the 1638 *stock* combinations of Duti-Rated Helical Gears.

When you buy Duti-Rated Gearing, you'll get more than best for your money . . . you'll get the benefit of thousands of engineering and development hours . . . and the unquestioned advantages of precision tooling and manufacturing methods. You'll get performance proven in countless Foote Bros. Line-O-Power and special drives, and Foote Bros. —Louis Allis Gearmotors. This is high hardness, accurate, balanced design gearing that will give you more load capacity and wear life per dollar.

**Larger sizes made to order from standard tooling.*

Write for DUTI-RATED catalog: Engineering Manual DR No. 2.

150 WORM GEAR COMBINATIONS



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Center Distances.....2" to 12"†

Need worm gear and worm sets? There is economy and convenience in choosing them from the many Foote Bros. worm gear combinations available from stock. This is the same gearing used in famous Foote Bros. HYGRADE Enclosed Worm Gear Drives . . . engineered, premium quality gearing at production-run prices.

Engineering Manual SW No. 1 has complete details. Write for your copy.

† Tooling available for larger worm gear sets, engineered, but not stocked, to 200 HP and 18" centers. Prompt deliveries.

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Let us help you select standard helical or worm gearing to meet your special requirements, or, let us design and build your complete unit. Place your gear problems in the hands of experienced power transmission and gear engineers. Your inquiry is invited, and there's no obligation.

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Hawaii *(Continued)*

and aluminum for many decades, at present rates of U. S. consumption."

The proposed legislation is before the Senate Subcommittee on Mines and Mining, headed by Sen. James E. Murray of Montana. There have been indications he may defer action until the Subcommittee can visit Hawaii, possibly after adjournment of the present session of Congress.

IDAHO

Continuing development work has exposed several hundred feet of additional strike length of the lead-silver ore shoot in the new Bonanza vein at Day Mines' Dayrock property north of Wallace. The added strike length is narrower in width, however, and considerably broken up by transverse faulting.

Company is continuing to enjoy good returns from its 25% share of silver-copper ore production from American Smelting & Refining Co.'s lease on the Vulcan-Galena Mine in the Coeur d'Alene District and from the leasing operations of Knob Hill Mines Inc. at Day Mines' Gold Dollar gold-silver property near Republic, Wash. Development work on the new ninth and tenth levels of the Gold Dollar is reported to be showing "markedly better results" than disclosed on higher levels.

Sidney Mining Co., one of Idaho's largest zinc-lead producers since World War II and now the last surviving operator in the Pine Creek area of the Coeur d'Alene District, was forced to reduce its working force by approximately two-thirds Feb. 15. About 26 men were idled by the curtailment. Depressed metal markets were blamed.

Bunker Hill Co. has reported 1957 net earnings of $1,158,000, or 69c a share, as compared with $3,020,000, or $1.87 a share, in the previous year. President John D. Bradley said the decline was due primarily to lower metal prices during 1957 and to larger depreciation charges under accelerated amortization. He said the company's Bunker Hill mine reserves are now the greatest in history and that development of the Crescent silver-copper-lead mine is continuing to show encouraging results.

Diamond drilling at the Conjecture silver mine in the Lakeview District of Bonner County has established the fact that the St. Regis formation, which is the host rock for most of the major silver ore deposits in the nearby Coeur d'Alene District, lies less than 200 ft below the bottom 700 level. All Conjecture production so far has been from the overlying Wallace formation, a much less favorable host rock, and the drilling was undertaken to determine proximity of the contact. Federal Uranium Corp. is developing the Conjecture property under an operating agreement with Conjecture Mines Inc.

Agreements fixing definite boundaries and settling complex ore rights prob-

B.F.Goodrich

B.F.Goodrich tires give strip miner 20% more mileage than other makes!

FAUZIO BROS. strips coal in the area around Nesquehoning, Pa. 72 trucks haul loads as heavy as 32 tons up steep, winding mountain roads. Tire failures were common in this grueling work. Then the company switched to B.F.Goodrich tires—today uses 480 of them! Why? Because B.F.Goodrich tires give 20% more service than any other make, reduce road delays, can be retreaded 2 to 3 times!

The new B.F.Goodrich Rock Service tire is a favorite with Fauzio because of its FLEX-RITE NYLON cord body. B.F.Goodrich FLEX-RITE NYLON withstands double the impact of ordinary cord materials, resists heat blowouts and flex breaks. This Rock Service body outwears even the extra-thick tread, can be retreaded over and over.

Husky Rock Service cleats grip the ground for positive traction in forward or reverse. The Rock Service is available in regular tube-type construction, or Tubeless construction that protects against bruise-blowouts and sudden flats. See the complete line of tires for mine work at your B.F.Goodrich dealer's. He's listed under Tires in the Yellow Pages of your phone book. Or write *B.F.Goodrich Tire Co., A Division of The B.F.Goodrich Co., Akron 18, Ohio.*

Specify B.F.Goodrich Tubeless or tube-type tires when ordering new equipment

B.F.Goodrich *truck tires*

This Bucyrus-Erie walking dragline stripping overburden in a Mesabi Range iron mine, feeds the hopper of a portable screening plant.

Bucyrus-Erie Walking Draglines Move Overburden High, Wide and THEN SOME

Not only do Bucyrus-Erie walking draglines move overburden *high* and *wide* from deep pits to spoil piles or hoppers — they traditionally move it *economically* as well. Their ability to move big yardages at consistently low cost has made them preferred for stripping operations everywhere.

Modern front-end design that combines great strength with light weight contributes to outstanding performance — by permitting Bucyrus-Erie walking draglines to swing big buckets on long booms. Ward Leonard variable-voltage control provides extra fast acceleration and deceleration to speed cycles. Exclusive Bucyrus-Erie walking mechanism permits smooth, fast moveups, easy maneuvering to most advantageous working position. These features plus month-after-month dependability and low maintenance are your assurance of high volume, economical production.

For moving big yardages economically, choose from the world's largest selection of walking draglines. Contact Bucyrus-Erie Company for full information. 154157

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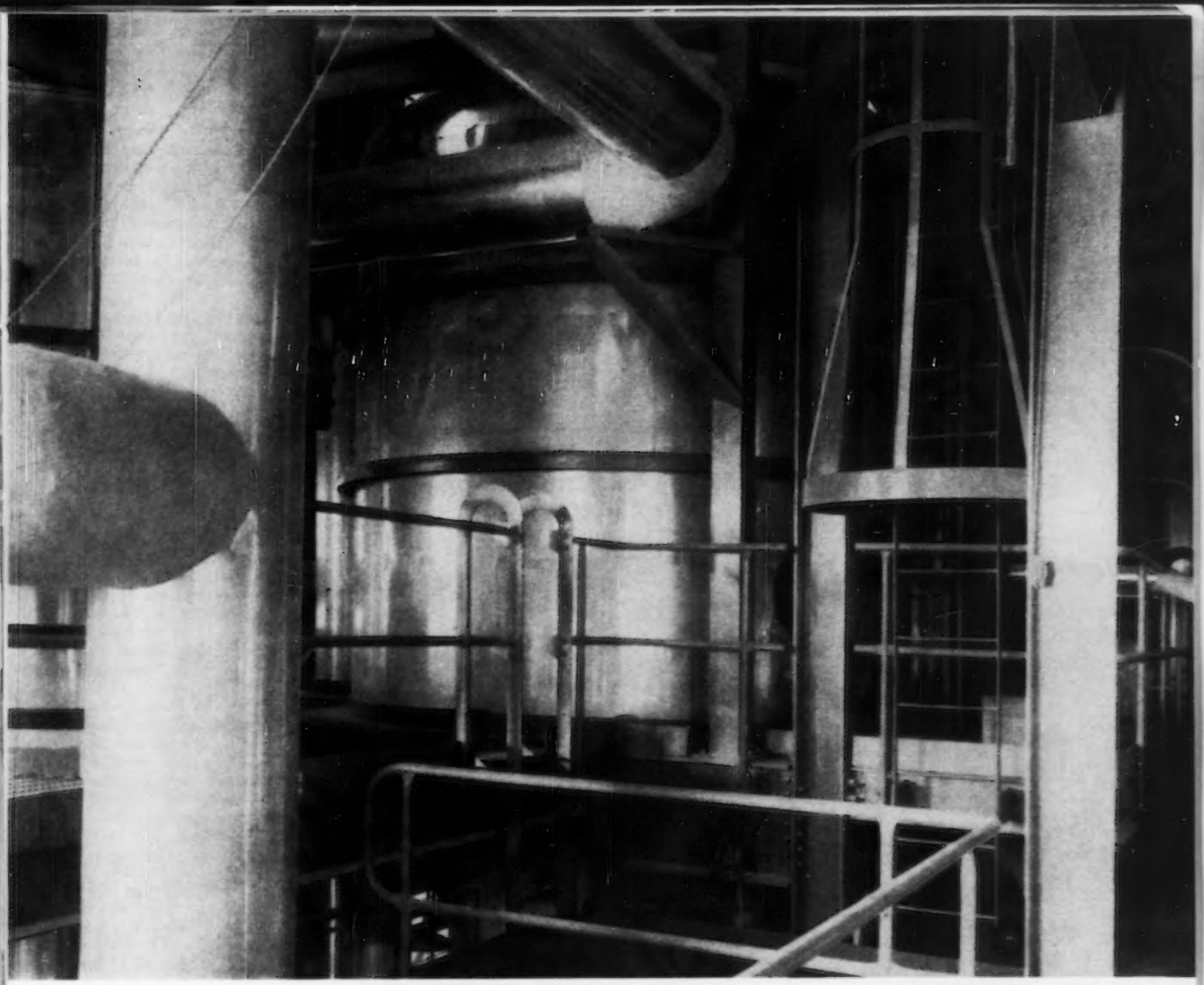

The equipment shown here is one of several unit processes in the refinery where Stainless Steel is required to resist the corrosive effects of the ammonium sulfate and ammonia used in this new extraction process.

Only Stainless Steel is good enough for this new extraction process

at Sherritt Gordon Mines,
Fort Saskatchewan, Canada

Sherritt Gordon Mines, Ltd. has a new method for extracting nickel, copper and cobalt from ore. The ore is dissolved in a bath of ammonium sulfate and ammonia and the metals are recovered from the solution.

Stainless Steel is the only metal that can be used in the pipes, tanks and pumps that give this "hot bath" to the ore. The ammonium sulfate and ammonia would eat away carbon steel, and other materials can't take the high pressures and temperatures in this work.

There is two million dollars worth of Stainless Steel in the plant. Stainless has proved to be more economical than any other material. It's strong and it resists corrosion. It eliminates costly maintenance problems.

If corrosion and replacement of equipment are problems in your work, think about using Stainless Steel. For more information about the application of Stainless Steel in mine work, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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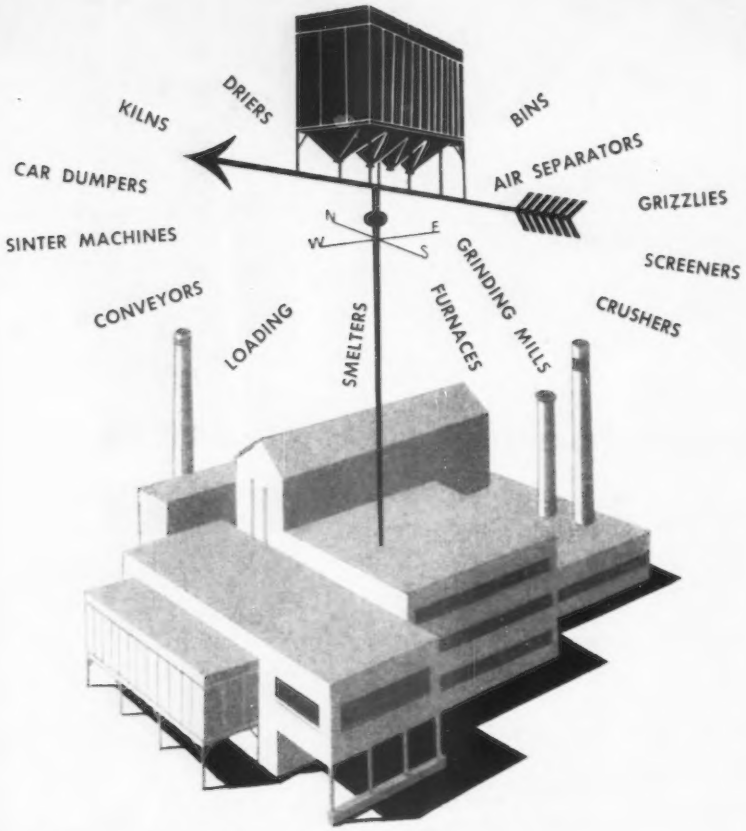

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Idaho *(Continued)*

lems in the Crescent Mine area of the silver belt west of Big Creek have been concluded as a result of more than two years of negotiation. Involved in one agreement are the Bunker Hill Co., Sunshine Mining Co., Sunshine Consolidated Inc. and Big Creek Apex Mining Co. The second agreement is between Bunker Hill and Aberdeen-Idaho Mining Co.

Principal objective of the settlements is to establish definite ore ownership boundaries which do not vary with the meandering of vein apexes and are not subject to varying interpretations under extra-lateral and intra-limital rights laws, according to Norman M. Smith, general manager of Sun Con and Big Creek Apex.

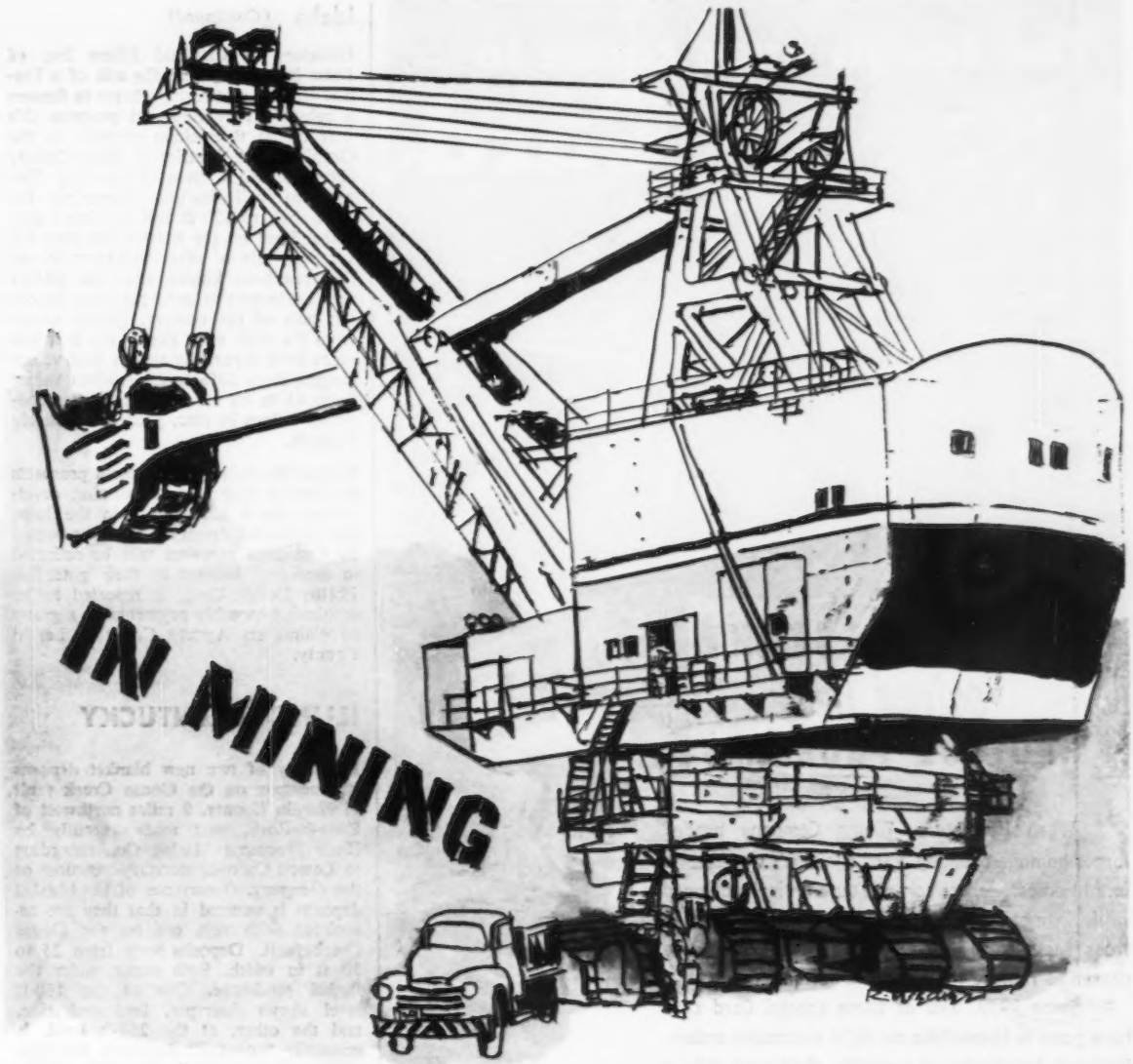
Agreement between Bunker Hill and the Sunshine-Sun Con group sets up a north-south vertical plane near the west end of Big Creek Apex ground and concedes all ore east of that plane to the Sunshine-Sun Con group, including that within Bunker Hill property below creek level. All ore west of that plane is conceded to Bunker Hill. This agreement also establishes an inclined plane extending westerly from the vertical plane to cover Bunker Hill's presumed extralateral rights beneath Sun Con ground.

Bunker Hill-Aberdeen agreement fixes the vertical boundaries between the two properties, established an inclined plane to cover Aberdeen's presumed extralateral rights beneath Bunker Hill ground, and provides for development of the Aberdeen property by Bunker Hill from deep levels of its Crescent shaft on a profit-sharing basis.

The settlements clear the way for important deep exploration and development projects in the silver belt area west of Big Creek.

Less than a year ago Bunker Hill concluded an agreement with Yreka United Inc. tying up most of the mining property west of Aberdeen holdings in the extreme west end of the silver belt. Previous development work in this sector has been confined largely to shallow surface workings. Bunker Hill is reported to be planning to connect its deep Crescent workings with those of the Bunker Hill mine at Kellogg, and thus provide access for deep-level exploration in the entire west silver belt area.

Sunshine Mining Co. has entered into an agreement with North Star Uranium Inc. of Spokane to undertake exploration and development of North Star's recently-acquired barite property on Queen of Sheba Mountain in Stevens County, Wash., about 10 miles north of Colville. If provisions of the contract are carried out Sunshine will acquire a two-thirds interest in the prospect on which barite lenses up to 25 ft wide have been exposed at the surface. The principal use of barite, a heavy white mineral, is as "drilling mud" for the oil industry and the Washington deposit is strategically located with respect to oil exploration now in progress in western Washington and Alaska.



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Its ready adaptability is evident wherever power is transmitted. It conforms to unique design requirements. Use wire rope to transmit power.

The tough ones come to Card

How HOMESTAKE solved two HAULAGE PROBLEMS

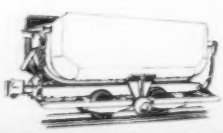
When Homestake Mining Company needed larger haulage capacity, Card engineers were called in. At Homestake, ore cars are automatically dumped while in motion, and haulage ways are limited in cross section. So, special Granby-type cars were chosen to replace the old gable-bottom cars.

Since 1939, 390 of these special Card cars have gone to Homestake on eight successive orders. Designed for maximum capacity, they have only a very minimum of side clearance. They are fabricated wholly of Cor-Ten plate and hold 60 cu. ft. Greatest design change over the years has been to a heavier liner plate to allow loading without the degree of ore fragmentation originally planned. Originally the cars were loaded through 14" grizzlies. Now they are loaded with the largest sizes that will clear the chutes.

Card has recently furnished 61 special Rocker Dump cars for development work at Homestake. These are well suited to handling waste and dumping in old stopes.

WHERE MINING CALLS

for efficient haulage, Card cars are the tested answer. Join Card's many customers. Their repeat orders are added proof of quality for you. Card engineers are at your service . . . no obligation.



C.S. Card Iron Works Co.

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DENVER, COLORADO

Idaho *(Continued)*

Directors of Richfield Mines Inc. of Boise have authorized the sale of a limited amount of treasury shares to finance a substantial development program this year on its three-claim property in the Granite Creek District of Boise County about 3 miles from Placerville. The program will include deepening the 70-ft shaft to 120 ft and opening a new 100-ft level on the narrow but rich Silver Star vein of silver-lead-bismuth ore that has been known since the district was an important gold producer before the turn of the century. Recent assays from the shaft sunk during the past few years have reportedly shown lead values ranging from 20% to 25%, silver values from 45 to 80 oz and additional recoverable values in zinc, gold and possibly bismuth.

Several thorium and rare earth prospects in Central Idaho are continuing development on a small scale in the hope that improved demand recently reported by Canadian suppliers will be reflected in increased interest in their potential. Phelps Dodge Corp. is reported to be continuing monthly payments on a group of claims on Agency Creek in Lemhi County.

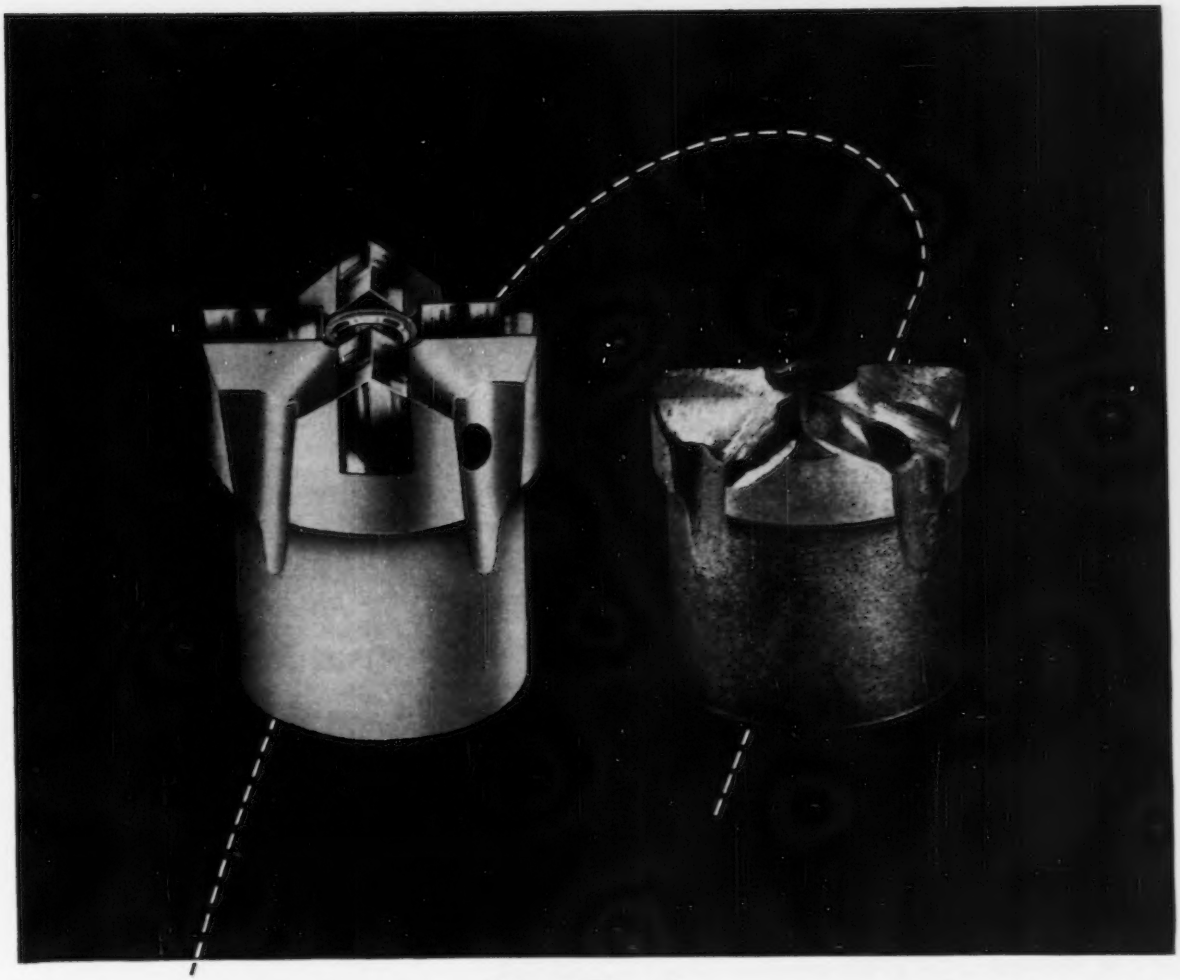
ILLINOIS-KENTUCKY

Discovery of two new blanket deposits of fluorspar on the Goose Creek fault in Hardin County, 9 miles northwest of Cave-in-Rock, was made recently by Hoeb Fluorspar Mining Co., according to Lowell Oxford, secretary-treasurer of the company. Occurrence of the blanket deposits is unusual in that they are associated with vein ore on the Goose Creek fault. Deposits vary from 25 to 30 ft in width. Both occur under the Bethel sandstone. One at the 160-ft level shows fluorspar, lead and zinc, and the other, at the 260-ft level, is primarily "coontail" fluorspar. Exploratory work is planned. Operators of the Hoeb are Amos Hill, Lowell Oxford, Carl Embree and Burrell Bales.

Construction of a new 145-ft shaft at the Deardorff mine in the Cave-in-Rock district, which was begun last December, has been completed by Ozark-Mahoning Mining Co., and mining started in February.

Minerva Oil Co. has leased a small acreage from Neva Deardorff, et al, which lies along the boundary line between the owners' two properties, for mining of fluorspar ore.

Domestic fluorspar shipments declined in 1957 and reached an estimated total of only 325,000 tons despite ore reserves and milling capacity substantially capable of supplying all of the nation's consumer needs, according to J. Blecheisen, president of Rosiclare Lead & Fluorspar Mining Co., Rosiclare, Ill., in an address before the Colorado Mining Association at Denver in February. Domestic producers, he said, are dismayed by the rising tide of foreign imports since im-



THIS JOY BIT DRILLED *46% Farther*... STILL MORE TO GO

YOU'LL FIND YOUR BIT SIZE IN THIS CHART

SHOULDER DRIVE	BOTTOM DRIVE	TAPER SOCKET
1½"		1¼"
1⅝"		1⅜"
1¾"		1½"
1⅞"		1⅝"
2"		
2⅛"	2½"	Note: Shaded areas are X-Type, others are Cross Type
2¼"	2¾"	
2⅜"	3"	
2½"	3¼"	
2¾"	3½"	
3"	4"	
3⅛"	4½"	
4"	5"	
4½"	5½"	
	6"	

WRITE FOR FREE BULLETIN 172-4

Drilling Rock with a scleroscope hardness of 90-100 takes a lot out of most carbide bits . . . on this job, other bits were averaging 532 feet. Our illustration shows a Joy bit before and after drilling almost 800 feet in this formation. The average for Joy bits on the entire job was 781 feet.

Here's why: OFFSET WINGS allow drag-free rotation, faster removal of cuttings, easy reconditioning . . . DEEP SLOTTED CHIP WAYS allow cuttings to escape; bit does not regrind its own cuttings . . . INSERT STAYS IN because of new brazing method . . . SPECIAL ALLOY STEEL BODIES heat treated for shock resistance and high fatigue life . . . PRECISION MILLED THREADS instead of tapped threads.

These are the reasons why Joy tungsten carbide bits give extra footage . . . and only Joy bits have all these features. Let your Joy representative prove it to you. ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

WSW C 6595-172

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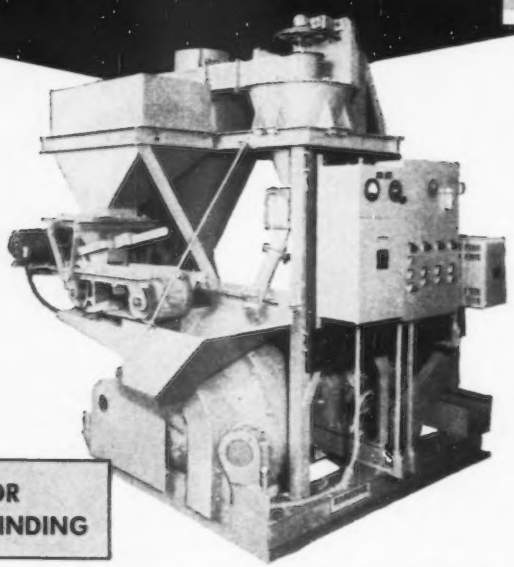
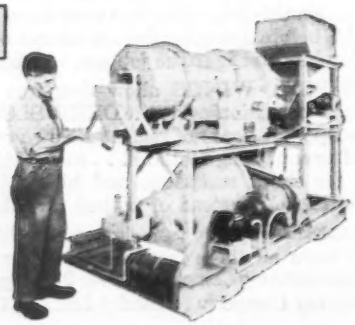


FOR DRY GRINDING

For any small-scale continuous dry grinding or pulverizing problem (such as is found in a pilot plant, laboratory or small commercial process) the Hardinge dry grinding unit is the solution. Completely self-contained and portable, this unit requires only power connections to be placed in operation. Includes Constant-Weight Feeder, "Electric Ear" grinding control, Conical Mill, "Gyrotor" Air Classifier, product collector and dust collector.

FOR WET GRINDING

Hardinge builds a similar unit (right) for small-scale wet-grinding applications. The "package" includes mill, classifier, feeder, "Electric Ear", and launders.



Bulletin AH 140-1

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Illinois-Kentucky *(Continued)*

portation last year totaled an estimated 620,000 tons, an increase of 135,000 over 1956. Domestic shipments decreased approximately 2% as compared with 1956 shipments.

Of the domestic tonnage, it is estimated that 110,000 went to Government stockpiling with only 215,000 finding a place in commercial market consumption. Long-range domestic reserves and mill capacity, present and readily available, are sufficient to meet all foreseeable needs of the future, he declared.

Improvement of its fluorspar flotation equipment to increase capacity and efficiency is being made by Southern Illinois Mining Co. at its Hardin County property, six miles west of Elizabethtown, which was purchased last November from Mackey-Humm Mining Co., according to R. D. O'Brien, company manager. The flotation plant, originally operated by Inland Steel at its Kentucky property but purchased by Mackey-Humm, was transferred to the Illinois site a year ago.

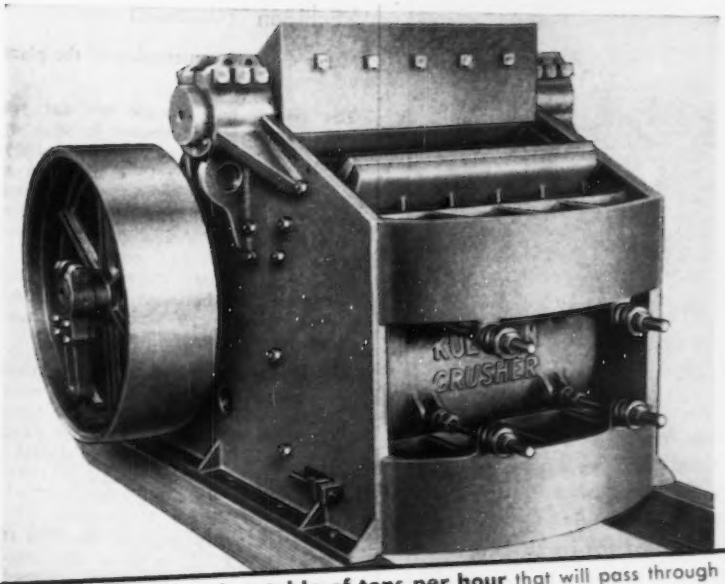
MICHIGAN

Bids were opened Feb. 19 by M. A. Hanna Co., Iron River District, for the construction of a two-level building at the new Homer-Wauseca shaft which will house change room facilities for miners on the lower level, and offices, warehouse, machine and repair shops on the upper. Building will be of brick, fireproof construction. It will serve the new concrete, 20 ft diameter circular shaft being put down by Walsh Construction Co. of New York. The shaft is down more than 1500 ft of its 2500 ft ultimate depth.

Vicar mine near Wakefield, which is connected underground with the Morgan mine (idle more than 25 years) is being considered as a permanent water supply for the city. Records show that the average water pumped from the Vicar when it was abandoned by Jones & Laughlin Steel Corp. about eight years ago, was 550 gpm. Mine produced about 100,000 tons of ore during its brief operation.

Oglebay, Norton & Co., from the Montreal mine on the Gogebic range and the St. James and Canton on the Mesabi range, shipped 2,014,272 tons in 1957. Montreal mine at Montreal, Wis., the Gogebic's most western producer, shipped 929,998 tons. The Montreal has averaged over 1-million tons per year for the last 11 years.

Cleveland-Cliffs Iron Co. shipped 179,185 tons of jasper concentrates in 1957 from the Humboldt mine at Humboldt on the Marquette range. The first pellets made from Michigan jasper (similar to the Mesabi taconite) were produced and stock-piled at the Humboldt Feb. 26, 1954. The plant has a capacity of about 250,000 tons per year. Humboldt Mining Co. was organized in 1951 by Cleveland-Cliffs and the Ford



KUE-KEN® CRUSHER gives greater capacity at lower operating cost

Here is a table of tons per hour that will pass through crusher with jaws set at dimensions shown when measured in the closed position.

Kue-Ken crusher size	¾"	1"	1¼"	1½"	2"	2½"	3"	3½"	4"	5"	6"	Horsepower range
24" x 12"	22	26	32	36	43	50	56					15 to 30
30" x 12"	32	35	38	42	55	70	76	85	110			20 to 30
36" x 10"	38	47	57	67	80	91	105					25 to 40
36" x 20"					70	82	90	115	135	160		30 to 50
42" x 25"					90	120	150	165	180	215	250	40 to 60

Table is based on crushing average hard dry quartz or similar rock weighing at least 100 lbs. per cubic foot when crushed. 32 sizes available from 12" x 5" to 48" x 42".

Kue-Ken crushes more tons per hour for its size than any other crusher. A built-in lubrication system allows Kue-Ken to operate at more crushing strokes per minute for greater capacity and more uniform product. Sealed against dirt and grit, the mechanism operates smoothly avoiding costly downtime and repairs unavoidable with crushers without a lubrication system. With minimum friction, Kue-Ken requires substantially less horsepower to operate. An automatic fly-wheel release prevents damage from tramp iron. Operating on an exclusive "crushing without rubbing" action, Kue-Ken jaw plates last at least 5 times longer. Kue-Ken is the most profitable crusher to use for any crushing requirement. See in the adjoining chart how a smaller, less costly Kue-Ken can provide the capacity you require.

WRITE FOR CATALOG

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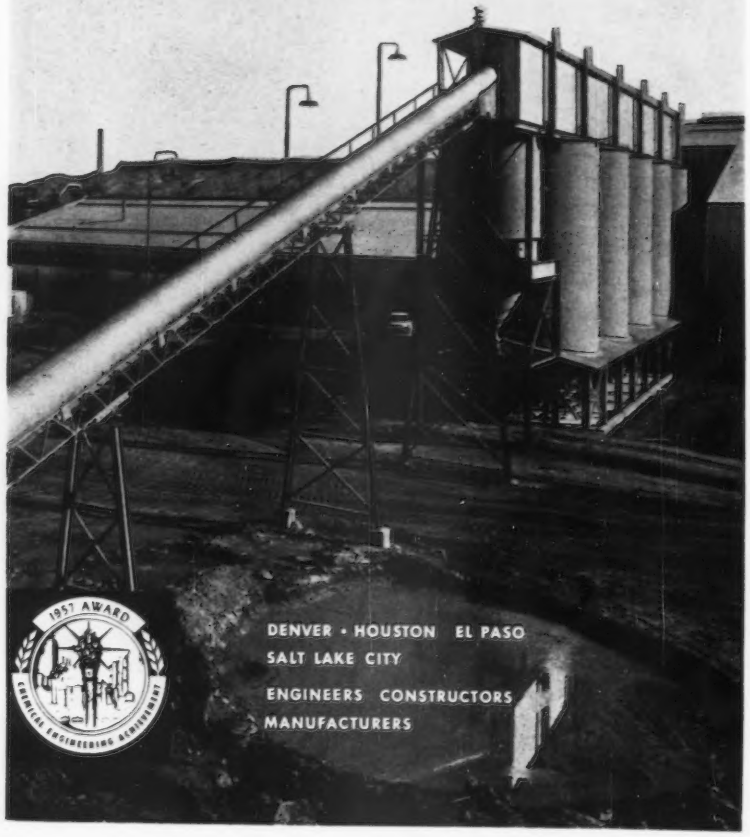
CAKE

Good equipment properly arranged produces a better cake. This processing mill, built by Stearns-Roger, is an efficient work shop for uranium processing.

The same outstanding services apply in every Stearns-Roger project, metallurgical, nonmetallic or chemical processing.

One responsibility—one order ...for design, fabrication and construction—new plant or a modification—rely on the experience and the facilities of Stearns-Roger.

Stearns-Roger
THE STEARNS-ROGER MFG. CO. • DENVER, COLORADO



1957 AWARD
CHEMICAL ENGINEERING ACHIEVEMENT

DENVER • HOUSTON EL PASO
SALT LAKE CITY
ENGINEERS CONSTRUCTORS
MANUFACTURERS

Michigan *(Continued)*

Motor Co. and construction of the plant was begun in 1952.

The missed hole danger has not yet been completely eliminated in spite of close supervision and effective safety regulations. On Feb. 15 a miner in a shaft sinking operation in the Iron River district lost a leg and suffered other injuries when he drilled into a missed hole. The crew had employed their usual precautionary measure of cleaning up the shaft bottom with compressed air and blow pipe. Fortunately the hole did not contain a full charge.

Pickands Mather & Co.'s six Gogebic range mines, lead by the Peterson with 561,489 tons, produced 2,627,746 tons, making them the largest shipper from the range. 1957 was the Peterson's biggest shipment since its first in 1951. The mine is composed of the old Puritan, Ironton, Yale and Colby mines. The Puritan shaft was deepened to 3900 ft in 1951. PM's only mine on the Marquette range, the Volunteer, shipped 88,891 tons in 1957.

MINNESOTA

With iron ore inventories at lower lake furnaces at a high level and steel production at a low rate, mining men in the Lake Superior area are not optimistic about the 1958 season, particularly as to its early months. They are still hopeful that conditions may improve in time to affect the last months.

M. A. Hanna Co. produced 12,882,384 tons from the Lake Superior area in 1957, an increase of 421,000 tons over 1956 and placing it second only to Oliver Iron Mining Div. in total shipments. Its ore came from the Menominee range of Michigan and the Mesabi and Cuyuna ranges of Minnesota. 300,579 tons was produced in Fillmore county in southern Minnesota. Company's largest producer was the Hunner open pit mine in Coleraine with 1,297,172 tons.

Pickands Mather & Co., in third place as to total shipments in 1957, shipped 1,106,587 tons and was again the only company to ship from the three Minnesota and three Michigan ranges. Its 1957 production was 105,784 tons less than in 1956. The Mahoning pit, as it has many times before, was in first place with 1,774,937 tons. No other of PM&Co's 24 active properties reached the million-ton mark.

Pickands Mather & Co. announced on Feb. 14 a further reduction in work schedule at its Zenith mine in Ely. The new schedule, affecting about 280 men, provides three four-day weeks for each man followed by one week lay-off, giving 12 days of work for four weeks.

Cleveland-Cliffs Iron Co's shipments for 1957 amounted to 8,100,485 tons, making it the fourth largest producer after Oliver Iron Mining Division, M.A.

The DART 35SL, hauling 35 Tons Payload. Proven lower cost per ton. Lower load-weight ratio. Just ONE engine, transmission, rear axle!

PROFITABLE PAYLOADS WITH Dart TRUCKS

DART TRUCK COMPANY builds a complete line of trucks—from 10 to 50 Ton payloads. *But*, any model can be built to meet your special haulage requirements.

DART 13S-UG underground shuttle truck with dual controls and through conveyor.

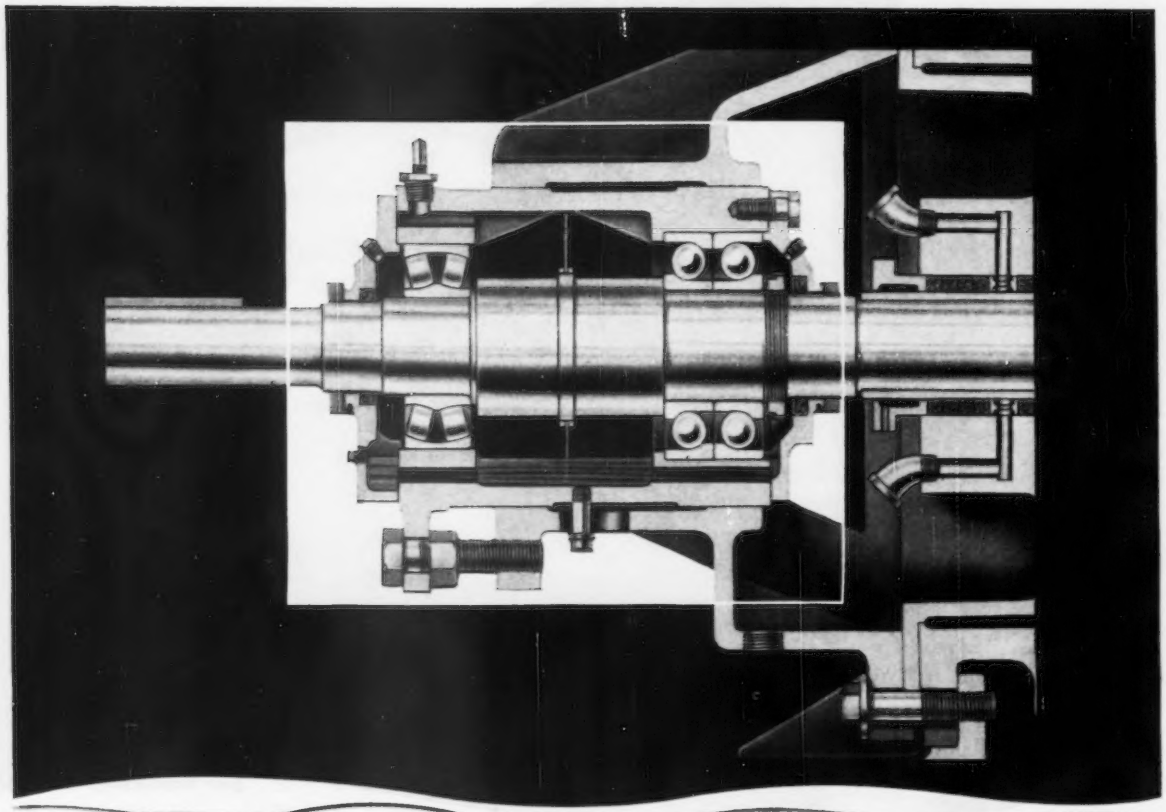
DART's 50 Tonner powered by a 400 or 600 HP Diesel Engine for that big payload.

WRITE FOR SPECIFICATIONS TODAY

DART TONNAGE ENGINEERED TRUCKS
Kansas City 8, Missouri

D-140

BULLETIN! MARCH 14 DART MERGED WITH KENWORTH MOTOR TRUCK DIVISION OF PACIFIC CAR AND FOUNDRY COMPANY. NEW NAME KW-DART TRUCK COMPANY.



New bearing bracket

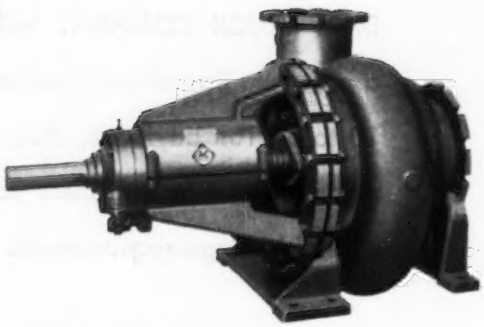
takes reverse thrust

Locked-in bearings mounted back to back in Allis-Chalmers CW solids-handling pumps, permit thrust from either direction. Thrust reversals will not damage bearings.

In addition to locked-in bearings, the new bearing bracket has other advantages — among them:

1. Simple conversion from oil to grease lubrication.
2. *Three* bracket groups to cover all *nine* pump sizes for maximum parts interchangeability.
3. Simplified clearance adjustments between impeller and side plate by means of the cartridge-type frame liner to compensate for wear and consequent loss of efficiency.

This new bracket is standard on all Type CW solids-handling pumps. Contact your A-C office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.



Nine CW pump sizes for either direct or Texrope drive.

Texrope is an Allis-Chalmers trademark.

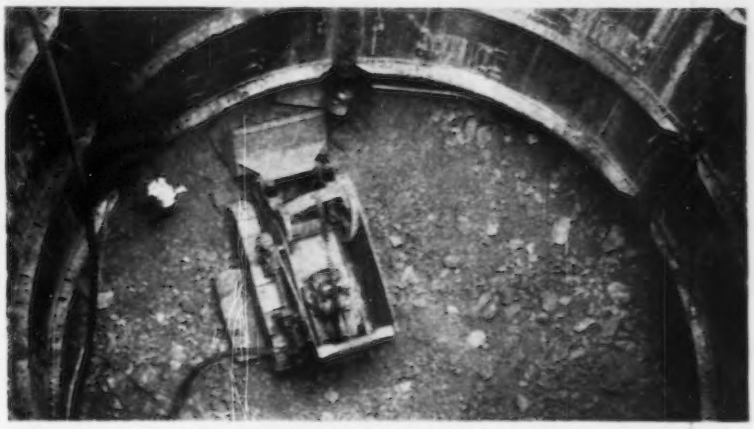
ALLIS-CHALMERS

A-5704

HERE, IN MISSOURI'S PEA RIDGE IRON ORE REGION, Meramec Mining Co. (joint venture of St. Joseph Lead and Bethlehem Steel) is sinking a 22 ft dia shaft down to the deep lying deposits. Major railroad, steel producing and mining firms have shown interest in Pea Ridge's 60% ore, and are now laying plans to begin work.

DIAMOND DRILLS, now at the 2,828-ft level, and, according to Meramec, still in good iron ore, will be drilled down to the 4,000-ft level if necessary.

THROUGH THIS 100-FT, horizontal access tunnel, men and machinery will be able to enter Meremec's shaft without having to climb to the top of the ridge.



AT THE BOTTOM OF MERAMEC'S SHAFT, a pneumatic loader speeds digging operations. Atop the digging area: crews pour an 18-in. concrete shell in 20-ft. sections. Officials say the $1.5-million shaft should be at the 1,000-ft level within a year. Core samples have contained as much as 65% iron.

Minnesota *(Continued)*

Hanna Co. and Pickands Mather & Co. Its shipments came from two ranges; the Marquette in Michigan—4,819,502 tons; and the Mesabi in Minnesota—3,280,983 tons. It has long been the largest shipper from the Marquette range and is the only one of the first four in 1957 to mine more ore from Michigan than from Minnesota.

Cleveland-Cliffs Iron Co., largest independent producer and seller of iron ore, has announced that prices of ore will remain the same as in 1957. This will be the second year since World War II that prices have remained unchanged, the other being 1954.

Reserve Mining Co. announced that it would go on a temporarily reduced schedule. Since Reserve began operations in 1955, it has been in operation 24 hours a day, seven days a week. It is believed that no other ore production plant on the range can equal that record. The new schedule provides employes will work four straight weeks, followed by one week of lay-off. About 1,100 men will be affected. The plant will close at midnight on Saturdays for its week of idleness.

Oliver Iron Mining Division, largest producer of iron ore in the Lake Superior area, shipped 33,473,559 tons in 1957, all from two Minnesota ranges—the Vermilion and the Mesabi. This was about 4.4-million tons more than for 1956. The Pioneer underground mine on the Vermilion range produced 766,077 tons less than Pioneer has shipped in recent years. Opened in 1888 by Pioneer Iron Co., the mine has produced nearly 35-million tons during the 70 years of its life with over 6-million estimated tons remaining. The Mesabi range accounted for almost 32½-million tons of Oliver's total, the Rouchleau group at Virginia, including the Sauntry, shipping over 7¼-million and the Sherman group, between Chisholm and Buhl, nearly 6-million tons. Hull-Rust group at Hibbing contributed over 2½-million tons and the Pilotac plant at Mt. Iron shipped 664,243 tons of taconite concentrates.

During less than two months of the latter part of the 1957 season, Erie Mining Co. shipped 112,537 tons of taconite pellets through the new docks at Taconite Harbor.

A new process for concentrating low grade iron ores and a new pilot plant were inaugurated at Virginia Jan. 30, with Gov. Orville L. Freeman starting the machinery. It is known as the Oreclone plant, and according to Gen. L. J. Harris, general manager of the Oreclone Co., it produces a higher recovery at a lower cost than do conventional plants. First crude ore to be tested in the new plant comes from the tailings basin of the Prindle mine near Virginia.

Minnesota (*Continued*)

President R. T. Elstad of Oliver Iron Mining Division, in a letter to employes, said the company's ore production schedule for the 1958 season may be reduced by as much as one-third.

R. C. Wallace, assistant manager of Minnesota mines for M. A. Hanna Co., said their shipments for this year will be less than for 1957, "but how much or how little we do not know."

D. M. Chisholm, assistant general manager taconite operations, said that Pickands Mather & Co. were not prepared at present to predict what their schedule would be for 1958.

MONTANA

A high grade barite property of five mining claims located six miles south of Troy, was sold by James B. Robinson, Spokane, Wash. to Lendal H. Kotschevar, Missoula, and Donald Kotschevar, mining engineer, Sandpoint, Idaho.

Exploration and assessment work under the supervision of Donald Kotschevar has exposed by open cuts and trenches four different barite veins. The veins are reportedly contained in a barite mineralized zone of about 1200 ft wide by 2,000 ft long. The veins are steep in dip and range from 3 to 4 ft in width with one exposure measuring over 7 ft. Because of the limited amount of exploration work, the lateral extent of the veins has not ben determined; however, all the veins show good persistency in length and width. One vein appears to be over 2,000 ft in length, owners say.

Sawyer Petroleum Co., Los Angeles, announced that it is acquiring one of the largest known thorite deposits in North America to produce thorium concentrates for missiles, aircraft and nuclear reactors.

The deposit is on the extreme western edge of the Horse Prairie country, southwest of Dillon and almost directly west of Armstead. Nearly the entire known thorite deposit reportedly is located in Beaverhead County. Lemhi Pass is the crossover point on the Armstead-Salmon (Idaho) highway.

E. W. Sawyer, president, said the firm will purchase from Ragand Minerals Co., Dallas, Tex., the thorite deposit at Lemhi Pass on the Idaho-Montana border.

First half of 1957 saw progress on Anaconda's Northwest Project, according to the company's annual report, with hoist, headframe and surface plant completed at the Missoula shaft and sinking to 571 ft. At the Ryan shaft, temporary hoists and sinking equipment were installed. Work was suspended in July.

Also suspended were a special development program for copper and zinc ores in "outlying areas" of the district and the Elm Orlu-Black Rock low-grade zinc project. But, the company says, drilling in the Continental area has disclosed 50-million tons of complex low-grade copper ore "mineable by open pit methods."

NEVADA

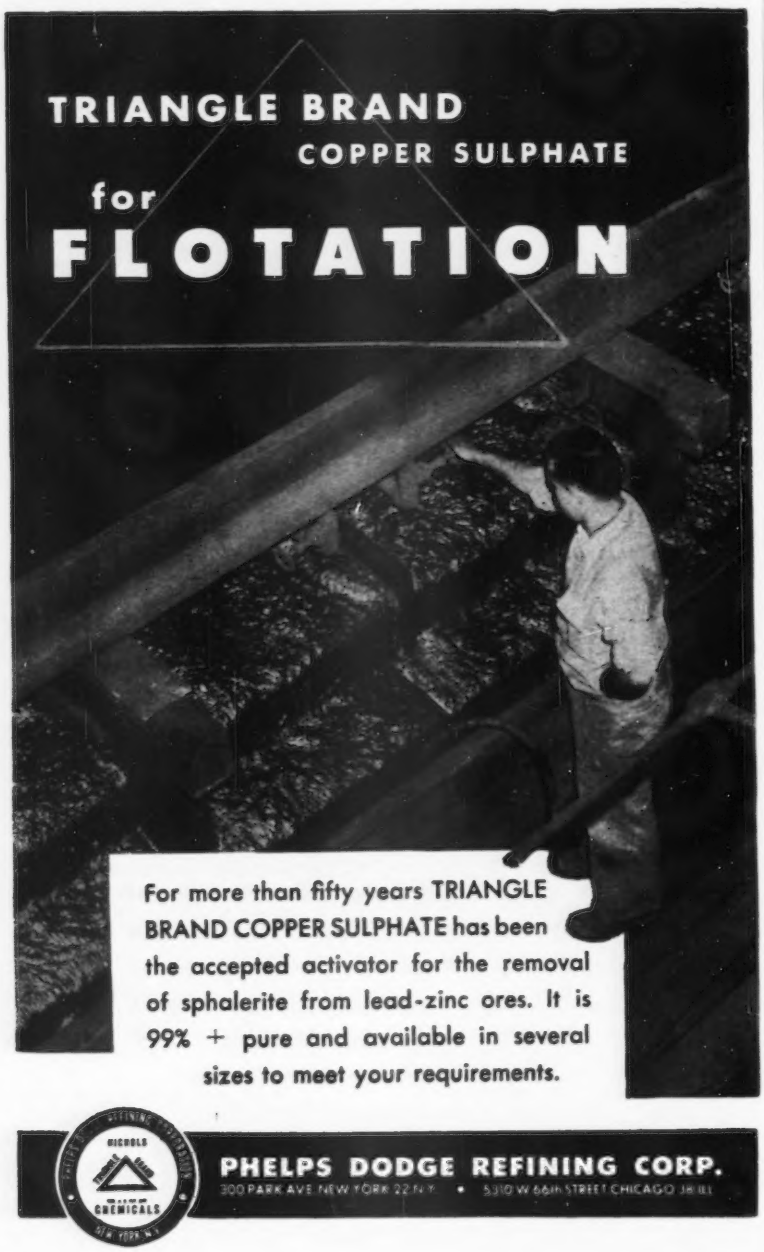
Construction has started on a diatomaceous earth plant for Eagle-Picher Co. at Lovelock.

The Eagle-Picher plant, designed earlier and now being built by Kaiser Engineers, will be valued at more than $2-million when completed in August 1958. In addition to constructing the main facility, Kaiser Engineers will also install its machinery. The project includes an L-shaped steel-frame structure 80 ft high, 63 ft long on one side and 51 ft on the other, supporting the drying and classifying equipment. Machinery and equipment to be installed, among other things, include a 9x120-ft rotary kiln, blowers, cyclones, traps and an air heater.

Although its principal mining properties have been sold to Kennecott Copper Corp., Consolidated Coppermines Corp. will continue exploration work in the west for minerals and metals, according to A. J. O'Connor, vice president and general manager at Kimberly for Coppermines.

All of Coppermines' holdings in White Pine County were sold to KCC and are now in process of being integrated into Kennecott's Nevada Mines Division.

O'Connor said exploration area headquarters would be established either in


TRIANGLE BRAND
COPPER SULPHATE
for
FLOTATION
For more than fifty years TRIANGLE BRAND COPPER SULPHATE has been the accepted activator for the removal of sphalerite from lead-zinc ores. It is 99% + pure and available in several sizes to meet your requirements.
NICHOLS
CHEMICALS
PHELPS DODGE REFINING CORP.
300 PARK AVE. NEW YORK 22 N.Y. • 5310 W. 66th STREET CHICAGO 38 ILL.

"Not merely to sell; but to serve . . . not only to make good steel products; but to make them still better . . . not only to fulfill today's requirements; but to anticipate tomorrow's—these are the principles that constantly guide CF&I."

G. F. Franz
President

Grinding Mill Bulletin #3

This series of ads on grinding ball rationing of the makeup charge is being presented by CF&I in keeping with our policy *"Not merely to sell; but to serve"*. It is our hope that the series will shed some new light on the subject by expressing established principles in practical terms, and that grinding mill operators who are interested in increasing the efficiency and production capacity of their ball mills will find this information of value.

The One-Size Ball Makeup Charge In An Operating Mill

Previous articles in this series have pointed out that determining the optimum size assortment of grinding balls that should be added as a makeup charge is a practical means of improving mill operation; and that the best makeup charge of one-size balls should be established before an attempt is made to work out a rationed makeup charge.

It is better to use oversize rather than undersize balls in the makeup charge. The reason for this is that there is always the possibility of encountering ores that are more difficult to grind. The larger ball would reduce this difficult-to-grind ore, whereas a smaller ball would not. This leaning towards oversize balls is recommended even though they will give fewer contacts and less attrition grinding than a smaller ball.

Indications of Incorrect Ball Size

In a closed circuit mill, a too-small ball size will fail to reduce larger feed particles, and too much tramp oversize will be circulated. Thus, the circuit will become choked, and you will find it necessary to reduce mill feed. With a too-large ball size, coarse particles will be reduced in size, but excessive amounts will need further reduction and excessive slimes may be produced from the impact of large balls. The partially reduced ore particles will overload the classifier, making a reduction in mill feed necessary. Thus both too-small or too-large balls will lower mill production.

In an open circuit mill, balls that are too large do not produce the fineness of grind, or liberation size, required, and they may produce too many slimes. Grinding balls that are too small, on the other hand, permit tramp oversize to enter the next process.

Price May Be Deciding Factor

The 3″ diameter steel ball is commonly the lowest-priced ball available whereas small size grinding balls are priced higher. The 3″ balls are used most frequently in beneficiation mills and are usually obtainable on an immediate-shipment basis. However, where 3½″ and 3″ diameter balls give similar results in grinding a particular ore, the 3½″ ball may be chosen because of the insurance it provides against the production of tramp oversize should more difficult-to-grind feed ore be encountered later. Nevertheless, the lower price of the 3″ ball may be the deciding factor.

Radical Changes are Undesirable

As in other experimental work in an operating circuit, it is good practice not to make too radical a change in the ball size used. Where it is indicated that 4″ diameter balls would be more satisfactory than the 3″ balls in use, it would be wiser to test 3½″ balls first, then check results to prove you are going in the right direction. Or, if it is considered that 2½″ balls will improve results as compared with the use of 3″ balls, it may be better to substitute 2½″ diameter balls for one-quarter or one-half the charge and then check for improvement before using 2½″ balls as 100% of the makeup charge.

Whatever the optimum size grinding ball you need for the makeup charge in your operating mill, you'll find it available from CF&I . . . in diameters from ¾″ to 5″. CF&I grinding balls are forged from special analysis steel and are carefully inspected—throughout production and again immediately prior to shipment—to ensure that they are free of surface pits, circumferential ridges or other surface unevenness. The CF&I representative nearest you will gladly give you complete details.

In the next article in this series, we will discuss general methods of rationing, and the specific steps to be taken in working out a ball ration.

For a reprint of the article on which this ad is based, please write on your company letterhead to: Mining Supply Department, The Colorado Fuel and Iron Corporation, P.O. Box 1920, Denver, Colo.

OTHER CF&I STEEL PRODUCTS FOR THE MINING INDUSTRY

CF&I Grinding Rods · CF&I Grader Blades · CF&I Industrial Screens
CF&I Mine Rail and Accessories · Wickwire Rope · CF&I Rock Bolts

FORGED STEEL GRINDING BALLS
THE COLORADO FUEL AND IRON CORPORATION

Albuquerque · Amarillo · Atlanta · Billings · Boise · Boston · Buffalo · Butte · Chicago · Denver · Detroit · El Paso · Ft. Worth · Houston
Kansas City · Lincoln · Los Angeles · New Orleans · New York · Oakland · Oklahoma City · Philadelphia · Phoenix · Portland · Pueblo
Salt Lake City · San Francisco · San Leandro · Seattle · Spokane · Wichita

6083

Nevada *(Continued)*

Reno or Salt Lake City. Coppermines' company town at Kimberly will not be operated by Kennecott. Residents will be given an opportunity to buy the homes there.

Southern Pacific Railroad handled 571 carloads of iron ore from Pershing county mines during January. Shipments from Woolsey included 87 carloads produced by Nevada Iron Ore Co., headed by H. S. Thomas, and 38 carloads for Segerstrom & Heizer. Shipments from Colado included 160 carloads for Minerals Material Co.; 185 carloads for Dodge Construction Co., and 101 carloads for Bradley & Extrom. Shipments from Colado went to Japan by way of the port of Stockton, while shipments from Woolsey went to the domestic market.

Sam Levine, Chicago and Tonopah mining engineer who has taken over the big mill and Nivloc mine at Silver Peak, has set up headquarters at Tonopah's Mizpah hotel, where he is recruiting mill workers. Milling operations have already started on 40,000 tons of tailings from the Nivloc.

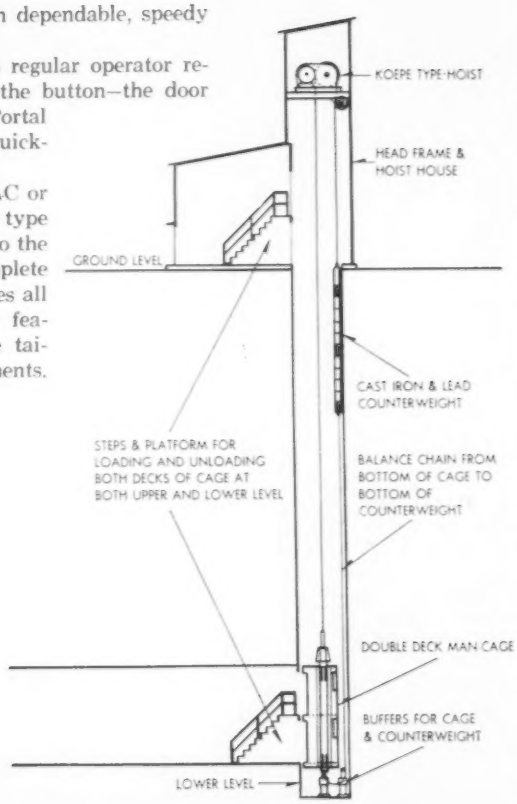
Round Mountain Gold Dredging Co. has completed extensive ground clearing work and has started heavy production at its property in Nye County. The Morrison-Knudsen Co., which has the contract for stripping and excavating operations, has had 90 men employed on the site since early fall.

Fully Automatic-Custom Built
CONNELLSVILLE PORTAL CAGE

This is the ultimate in dependable, speedy shaft transportation.

Economical, too—no regular operator required—step in—push the button—the door glides shut and the Portal Cage takes you there quickly—effortlessly.

Powered by either AC or DC friction (Koepe) type hoist which is geared to the speed you desire. Complete installation incorporates all the necessary safety features. Shape and size tailored to your requirements.


KOEPE TYPE HOIST
HEAD FRAME & HOIST HOUSE
GROUND LEVEL
CAST IRON & LEAD COUNTERWEIGHT
STEPS & PLATFORM FOR LOADING AND UNLOADING BOTH DECKS OF CAGE AT BOTH UPPER AND LOWER LEVEL
BALANCE CHAIN FROM BOTTOM OF CAGE TO BOTTOM OF COUNTERWEIGHT
DOUBLE DECK MAN CAGE
BUFFERS FOR CAGE & COUNTERWEIGHT
LOWER LEVEL

Send for descriptive bulletin

CONNELLSVILLE
MANUFACTURING & MINE SUPPLY CO.
CONNELLSVILLE, PENNSYLVANIA
SERVING THE MINING INDUSTRY SINCE 1901

NEW JERSEY

Reserves of titanium sands in southern New Jersey, according to a paper presented by members of the state Geological Survey at the annual meeting of AIME include the following: (in tons)

Area	TiO_2	Heavy minerals
North of Lakehurst	5,834,000	11,688,000
Colliers Mills-Keswick Grove	5,563,000	11,126,000

Figures were based on auger drilling to less than 20 ft, assuming 1.5% heavy minerals below the holes. TiO_2 tonnage was calculated on the basis of an average 50% content in the heavy minerals "this being a little less than the average of several analyses."

Pittsburgh-Pacific Co. of Hibbing, Minn., entered the high bid of $650,000 for the Ramapo Mountain Iron Mines at Ringwood, N. J. Bids were received by the General Service Administration in New York. The property contains 232 acres and has two known ore deposits. The mine has furnished ore for wars since the Revolution, but has not operated successfully in peace years. Pittsburgh-Pacific has no present plans for the Ramapo Mines.

NEW MEXICO

Chino Mines Division of Kennecott Copper has converted to waste removal on the upper pit levels by truck instead of rail, according to the annual report. Lower costs were achieved by the switch, KCC says.

Anaconda has added approximately 2-million tons to the company's ore reserves at Grants, according to the annual report. Stripping and mining rates were increased at the Jackpile.

NEW YORK

Major construction is now under way at Freeport Sulphur Co.'s $119-million nickel-cobalt project which on completion in the summer of 1959 will add substantially to the nation's supply of these vital metals, Langbourne M. Williams, chairman and president, announced in the annual report.

Operation, which will be conducted by a Freeport subsidiary, Cuban American Nickel Co., will produce 50-million lb nickel and 4.4-million lb cobalt annually from ores mined and concentrated at Moa Bay, Cuba, and refined in Louisiana, it was stated.

NOW — Continental-Wooldridge selects B. F. Goodrich Hi-Torque Brakes for giant tractor-scraper-dumper combinations

The B. F. Goodrich Hi-Torque Brake is a unique application of successful aircraft braking principles to the heavy duty off-road equipment field.

It's unique because it provides up to two and a half times the stopping power found in conventional two-shoe brakes. One Job Superintendent in Ohio had this to say after actual on-job tests of the brake. "We could operate on terrain operators considered unsafe for our equipment using conventional two-shoe brakes."

Secret of the B. F. Goodrich Hi-Torque Brake's amazing power is the exclusive hydraulic expander tube actuation. Providing equal pressure under each of 12 shoes in the B. F. Goodrich Hi-Torque Brake, this full-circle actuation allows shoes to follow drum eccentricities. Lining pressure is equalized—stops are smoother as well as faster—and there is less chance of fade even during long downhill runs. In addition, torque is always equal in forward or reverse.

If you build or use wheeled off-road vehicles of any description, send for the free folder—The B. F. Goodrich Hi-Torque Brake. It gives actual test results and specifications—describes how easy the brake is to install and service. Write: B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Troy, Ohio.

Continental-Wooldridge self-propelled Dumper and Scraper Models CWD-214, CWD-321, CWD-221, CW-215, CW-220, and high capacity tractor-drawn Scrapers, have capacities up to 30 yards struck and 39 yards heaped. 22" x 7" and 26" x 7" B.F.Goodrich Hi-Torque Brakes provide maximum stopping power.

B.F.Goodrich Hi-Torque brakes

New York (*Continued*)

Terming 1957 a "significant" year for Freeport, the report stated that reserves of sulphur, oil and gas, and potash were increased and that the company's sulphur reserves are now the largest in its history.

American Smelting & Refining Co., in its annual report, described a continued special interest in a "sizable copper orebody" at the East Pima project, near Tucson, Ariz. Initial drilling on the Indian reservation near the northern boundaries of the deposit "has picked up extensions of the mineralization."

Outlook for the deposit of "good grade heavy sands" near Lakehurst, N.J. with "a higher than average titanium dioxide content" indicates a favorable operation, the report said.

Asbestos production is expected in July 1598 from Black Lake Asbestos, which at full scale could produce 100,000 tons of fiber per year. Total cost of the project is now estimated at $36-million.

Expansion from 4,000 tpd to 7,000 is underway at Mt. Isa Mines in Australia, with completion set for late 1959.

Total expenditures at Southern Peru Copper Corp. (57¾ Asarco) for the year were $66.5-million. Cost may prove to be $30-million higher than first estimates.

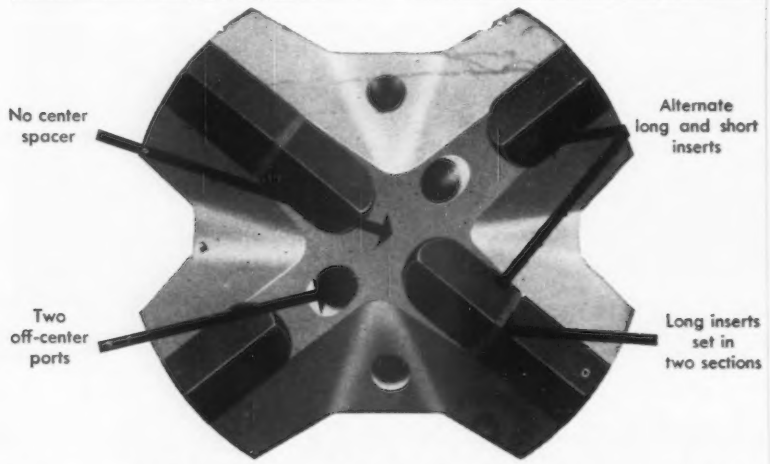
Inspiration Consolidated Copper Co. enjoyed increased recovery with use of the dual process on its oxide-sulphide ores after the switch from the ferric sulphate leaching process.

Completion of construction of a molybdenum recovery plant was expected in late April, with full-scale production several months hence. Development of the Christmas mine toward production was stretched out, with Inspiration taking advantage of the time to perfect plans and schedules.

Some $253,000 was spent by St. Joseph Lead Co. in preparation and equipment for the Viburnum project's No. 27 shaft in Washington County, Mo., where the company is investigating lead prospects.

Construction of a 500-tpd mill at Santander mine in Peru's lead-zinc deposit will be completed in 1958, St. Joe reports.

A roast-leach process is being investigated to handle the complex ores at Brunswick Mining and Smelting Corp., Ltd.



Only KENNAMETAL* PX Rock Bits

have these four exclusive features to give you faster penetration . . . longer service life

Each of these Kennametal features can mean savings to you:

- End milling the bit body to receive the carbide inserts eliminates the need for a center spacer
- Two short inserts permit two water ports to be located off-center where they will not clog.
- Setting the long inserts in two sections makes them stronger and lengthens bit life.
- "X" design eliminates rifling and speeds penetration by providing space for fast clearance of large chips.

*Trademark C-3068

Sizes from 2½" to 5" are available in the "X" design. Call your Kennametal Representative or write KENNAMETAL INC., Mining Tool Division, Bedford, Pennsylvania.

INDUSTRY AND KENNAMETAL ...Partners in Progress

OREGON

A $24,772 contract with DMEA has been signed by Timber Beast Mining Co., Prospect, for underground exploration of the company's uranium claims in Harney county. Timber Beast will pay for 25% of the total cost with the Government paying the balance, repayable from production of any ore developed in exploration. Timber Beast partners are W. C. Teegarden, Charles Skeeters, Glenn Young and George Slade.

R. L. Adams Jr., Carl W. Lange and Dean Lange have leased the Manzanita and Bluetop groups of claims on Quartz mountain in southeastern Lake County. A total of 12 claims is contained in the leased ground, where there has been considerable prospecting for cinnabar.

TEXAS

Dow Chemical Co. will close a portion of its magnesium facility at Freeport. Plant B, the company says, will be closed for an indefinite time.

Pan American Sulphur Co. plans output for 1958 of 800,000 long tons, according to president Harry C. Webb in the annual report. A second relay station to handle Frasch production from 20 wells, and a second loading installation were completed last year.

UTAH

Lisbon Uranium Corp. is selling $400,000 worth or uranium ore monthly, and expects to make $3-million in 1958 after mining costs, but before taxes, according to A. P. Kibbe, president.

Production is from the Ike and Columbia shafts in the Big Indian district of San Juan County.

Kibbe, who also is president of Hidden

Where a misstep costs $500... Blaw-Knox Electroforged® Steel Grating provides safer non-slip footing

Stair falls cost industry over $60,000,000 a year.

An average accident amounts to a loss of $500 in claims and a loss of 320 days.*

A good way to guard against these profit-eating accidents is to construct your stair treads, walkways and floors with Blaw-Knox Electroforged Steel Grating. Non-slip twisted crossbars and a wide variety of bearing bars are available to meet every kind of working condition—safely solving the most hazardous skid situations.

Rigid, one-piece construction makes installation easy. Once on the job, Blaw-Knox grating practically takes care of itself. There is nothing to wear, nothing to patch, no dirt collecting corners to clean. It goes anywhere, fitting neatly around pipes, beams and machinery, admitting plenty of light and air to the area.

Made to your specifications, Blaw-Knox grating provides new highs in safety, easy up-keep and flexible application. For new ideas about grating—including space saving platforms and shelving, write for Bulletin 2486.

*Based on a study analyzing 803 compensable work injury claims closed in Illinois involving stairs and steps.

BLAW-KNOX

BLAW-KNOX COMPANY

Equipment Division
Dept. S, Pittsburgh 38, Pennsylvania

Utah (*Continued*)

Splendor Mining Co., a wholly-owned subsidiary of Atlas Corp., said Hidden Splendor could expect monthly production rate of 7,000 tons of 0.30% U_3O_8 from its Big Indian District properties. The cash flow from the Almar Minerals ore body will be at rate of about $4-million a year, he said.

The Lisbon orebodies are of unusually high grade. Grade from the Ike shaft is well above 0.72% U_3O_8.

Ore from the Columbia shaft averages better than 0.35% U_3O_8.

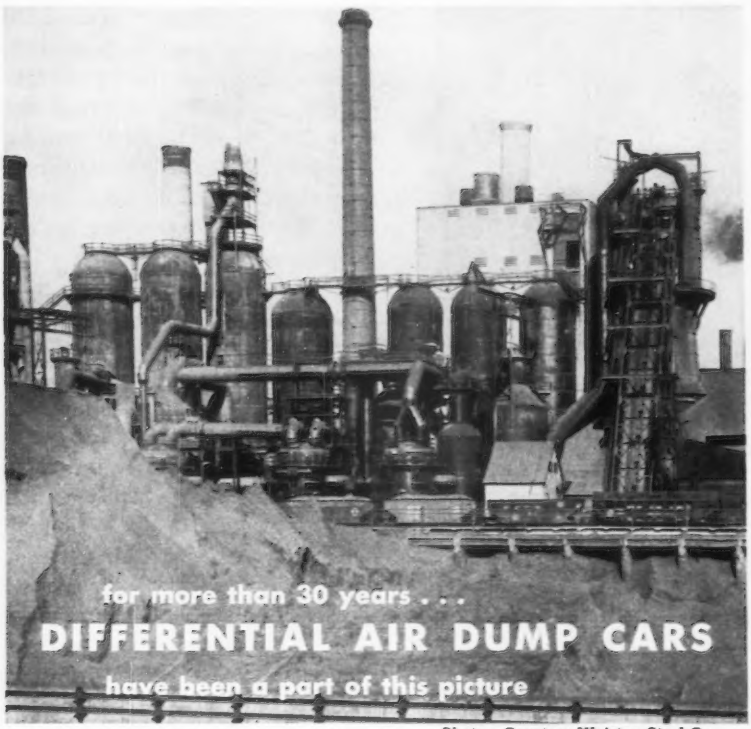
A reduction in the production work week from six- to five-day schedules has been announced by the Western Division of Kennecott Copper Corp. C. D. Michaelson, general manager, said the reduction would be effective in the latter weeks of March and would cut production by 12.5%. With the new curtailment, total cutback at Kennecott is now 20.5%.

New Park Mining Co. operations in the Park City lead-silver-zinc district of Utah were placed in the black for first time in many months during January and December through institution of leasing.

W. H. H. Cranmer, president, said the company was producing through contracts signed individually with some 60 lessees.

Between Jan. 1-Jan. 28, these men shipped 94 cars of ore with a gross value of $132,677 alone, he said. The lessees work under a complicated contract which relates the sliding scale payments to New Park on basis of ore grade.

The firm adopted leasing as an alternative to a permanent shutdown because of falling quotations for lead and zinc coupled with high labor and material costs in the mine.



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SINCE 1915 PIONEERS IN HAULAGE EQUIPMENT

WASHINGTON

Officials of the Pend Oreille County Public Utility District told a meeting of the Northwest Mining Assn. at Spokane recently that the PUD will not give up its Z Canyon dam site of the Pend Oreille River unless it can secure a partnership with Seattle City Light in the proposed Boundary dam, downstream from Z Canyon.

V. P. Campbell, manager of the PUD at Newport, Wash., said he felt the PUD was entitled to a 50-50 partnership on the project on the basis of the district's ownership of the upstream site at Z Canyon, which would be flooded out by the proposed Boundary project.

It was the second meeting that NWMA had arranged on the Boundary project. Earlier, the association heard Seattle Mayor Gordon S. Clinton outline the city's plans for the hydro project which would be constructed just south of the Canadian border. The NWMA and several mining firms in the Metaline mining district of Washington state have announced opposition to the project on the grounds that it would pose a potential flood threat to area mines.

Campbell told the NWMA that the PUD wanted to assure protection for the county's mining industry under an dam project proposed for the Z Canyon-Boundary stretch of the river.

He said the PUD is ready and able to build a dam at Z Canyon which would protect the area's mining properties.

A net income of $196,103 was reported by Grandview Mines of Spokane for 1957. This compared with a net loss of $54,079 for 1956.

Grandview officials said in the firm's annual report that income totaled $255,971. Of this, $250,000 was a capital gain on the sale of fully depreciated mining equipment and machinery to American Zinc, Lead & Smelting Co. American Zinc, which has operated the Grandview mine in the Metaline district of Washington for a number of years, last year entered into a purchase agreement with Grandview.

Officials of Northwest Magnesite Co. at Chewelah, said in March that the Chewelah plant operations were being suspended for a 30-day period. Plant manager Howard Ziebell said the move was due to what he termed a material decrease in steel production in the east.

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Washington (*Continued*)

He added that production will be resumed at the plant when steel production is stepped up, possibly within the next month. The plant at Chewelah employs about 250 men.

Northwest Uranium Mines, Inc., Salt Lake City, will commence stripping operations at its 607,000 ton low-grade uranium deposit on the Spokane Indian reservation, 50 miles northwest of Spokane, according to Clark L. Wilson, vice president and general manager of the firm.

Wilson said the company had given up all hope of: (1) securing approval of upgrading by the Atomic Energy Commission; (2) approval by AEC of an expansion of capacity of mill of Dawn Mining Co. to accommodate Northwest ore.

Grade of the 607,000 tons averages 0.124% U_3O_8.

North Star Uranium Inc., Spokane, said it has completed an agreement with Sunshine Mining Co., Spokane, on a barite property which Sunshine will explore in an area 10 miles north of Colville.

North Star plans to market the barite to the oil industry in Alaska. R. J. Hundhausen, mining engineer for North Star, said the company's holdings include a barite zone up to two miles in length.

WYOMING

Fremont Minerals, Inc. of Denver, Colo. has announced that Western-Knapp Engineering Co., of San Francisco has been awarded the construction contract for the company's uranium processing mill to be built at Riverton, Wyoming.

Western-Knapp is a Division of the Western-Machinery Co., also of San Francisco.

Field construction of the $3.5-million dollar plant get underway in March, and completion is scheduled for December of this year. The plant, designed to process 550 tpd, will be capable of treating both the high-lime and sandstone types of ore.

U. S. Steel's Columbia-Geneva Steel division has awarded to Bechtel Corp., San Francisco, a preliminary engineering contract for its proposed $16-million taconite ore-processing facility near Atlantic City.

Amount of the contract was not disclosed.

Columbia-Geneva officials emphasized a decision to go ahead with the Atlantic City processing facility has not yet been made.

Unofficial sources indicated the decision would be made by mid-April.

Shoni Uranium Corp., Riverton, has obtained an option to buy for $105,000 all capital stock in American Uranium and Exploration Co.

Stanford Clark, Shoni personnel manager, said Shoni has until April 13 to exercise the option. Most of Ameri-

Shovel with World's Greatest Appetite. The largest shovel ever built is now moving mountains of earth at the new River King Mine, Freeburg, Illinois. Owned by Peabody Coal Company, "Big Paul" digs out an incredible 105 tons of overburden with every bite of its 70-yd dipper. After filling this cavernous scoop, the giant excavator turns and deposits the load a city block away. In a single month it can move enough dirt and rock to fill a freight train 175 miles long!

"Big Paul" needs tremendously strong steel cables to handle this tonnage. The hoist lines have a diameter of 2⅝ in., and each is 530 ft in length. These enormous hoisting ropes were supplied by Bethlehem, the Purple Strand grade being specified. Purple Strand is Bethlehem's toughest, most durable wire rope—a product so strong that even the world's largest shovel can depend upon it.

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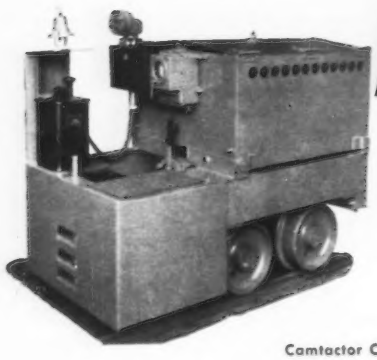

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Wyoming (*Continued*)

can's assets are in 36 uranium claims in the Copper Mountain area north of Lysite.

Lisbon Uranium Corp. has announced purchase of 103 uranium lode claims in the Gas Hills area from Fred Johnson, Kansas City, and the Samson Oil and Mineral Co., Fort Worth, Tex.

Johnson and Samson were paid $410,000 for their interest plus a 6% royalty.

Lisbon is also operating other uranium claims in Fremont county.

Sen. Frank Barrett (R.-Wyo) has proposed a program which would enable the AEC to fulfill its commitments with foreign countries for uranium and at the same time give the needed milling capacity to bolster the domestic uranium industry.

Barrett proposed that the AEC permit construction of additional mills with a daily capacity of 8,300 tons. Under his plan, the AEC would stockpile the yellow cake from the additional mills for four years, beginning in 1959 and lasting until 1962 when present contracts expire for purchase of foreign uranium.

Beginning in 1962 the ace would process a fourth of the stored yellowcake each year, in addition to current production. Barrett said by 1966 the entire stockpile would be liquidated.

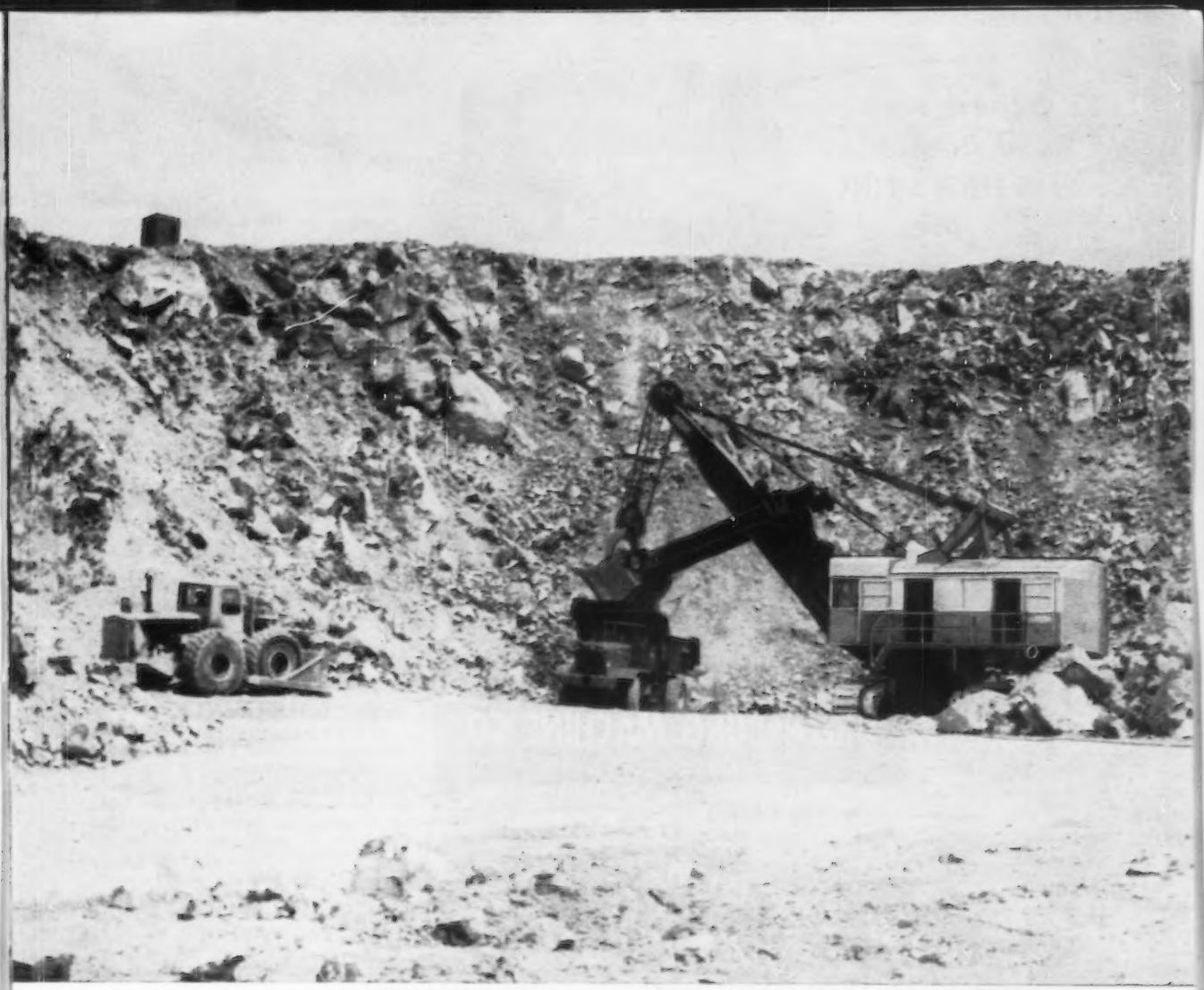
Barrett suggested that Wyoming be granted a total of 3,000 tons of the additional milling capacity.

IN CANADA

QUEBEC

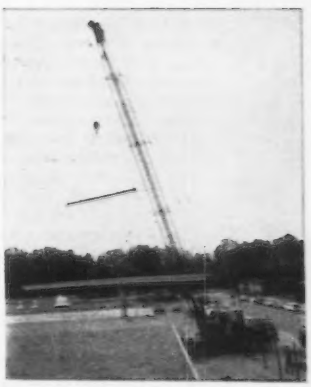
Quebec Iron and Titanium Corp. now has six furnaces in operation at its Sorel plant. Installation of the first of three new electric furnaces scheduled in its current expansion program was completed recently. The remaining two furnaces are expected to be completed by the end of this year. Annual capacity, when all eight furnaces are in operation, will be 350,000 tons of titanium slag and 300,000 tons of high grade iron.

Several companies have staked and optioned extensive acreage in an area near the Harricana River some 45 miles south and a little west of the Mattagami Lake district. Those in the area include Kennco Explorations, Canadian subsidiary of American Kennecott Copper Corp. which has a working option on several blocks of claims totalling 23,800 acres and has purchased and staked additional ground of more than 27,000 acres. Another major participant is American Metal Climax which has staked upwards of 20,000 acres in the area. An airborne magnetometer survey of the region carried out by the Geological Survey of Canada revealed a large spiral pattern of magnetic anomalies in a greenstone belt lying between two large intrusive masses of granodiorite. Publication of



Marions in Asbestos

This 6-yard Marion 4161 mines asbestos in south-central Quebec where nearly half the world's supply is produced. The 4161 and two 3-yard Marion 111-M electric shovels maintain a steady digging pace 16 hours a day in temperatures as low as 30 below zero.



Smaller Marions, like this 43-M Truck Crane on a construction job, get out a big day's work, too. The 40-ton crane can be equipped with a clamshell bucket for stockpiling or rehandling—can also work as a dragline.

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Quebec (*Continued*)

the results of the survey late last fall sparked interest in the area.

Aluminium Ltd. spent $51-million on the 1-million hp Chute-des-Passes project; $51-million for smelter and power facilities at Kitimat; and $44-million for bauxite and alumina projects in Jamaica, British Guiana and French West Africa, according to Nathanael V. Davis, president. Some 240,000 tons of primary capacity was deferred in 1957.

The company has concluded a contract with Norwegian government aluminum plants for supply of 1,720,000 tons of alumina over a 20-year period in exchange for ingot. A further expenditure of $100-million in 1958 will prepare Aluminium to bring in 235,000 tons capacity in addition to presently installed capacity of 770,000 tons.

Campbell Chibougamau, in its annual report, notes savings of 30c per ton of ore mined—anticipated with completion of a backfill plant at the mill. Backfill plant treats tailings "so that gangue materials can be sent back underground" for fill.

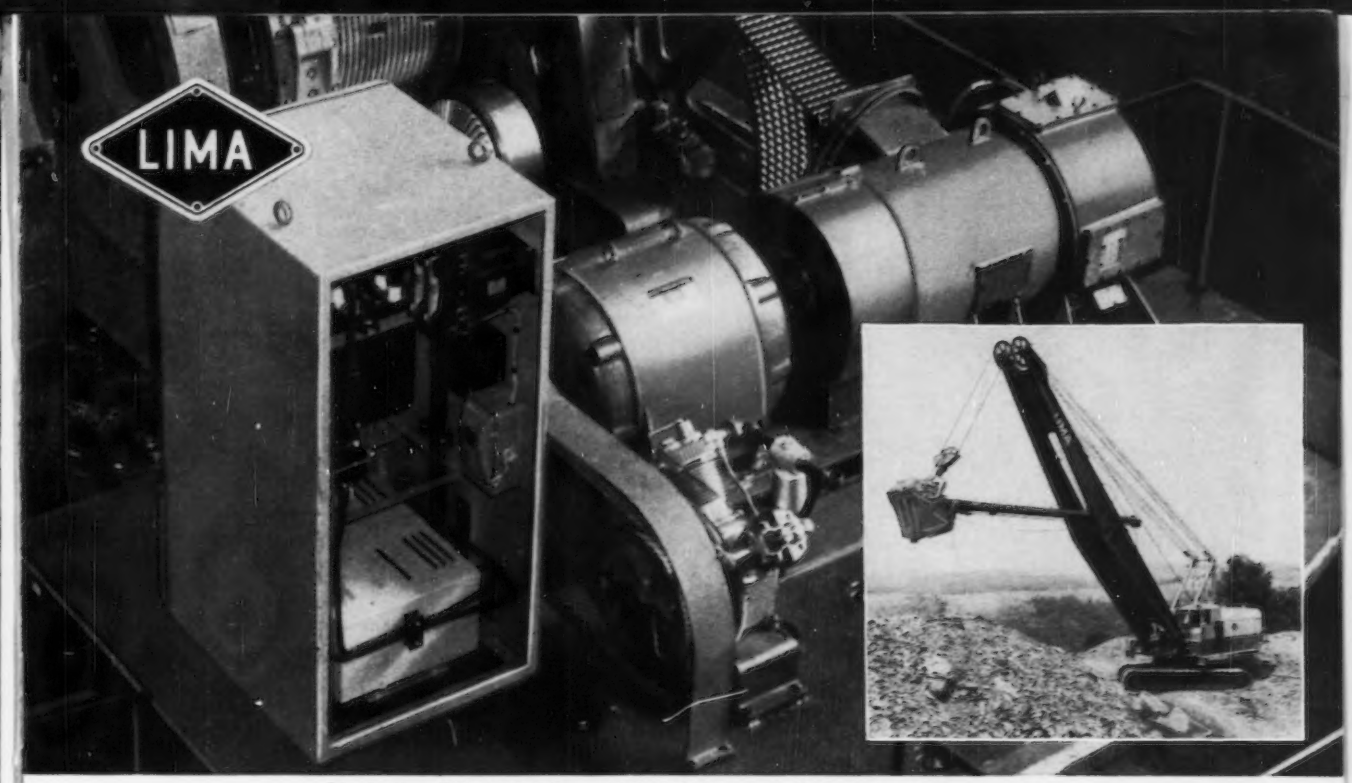
NEW BRUNSWICK

Strategic Manganese Corp. is continuing negotiations for financing its large scale manganese mining and smelting operation at Woodstock. Extensive test work at the prototype smelter of its associated company, Strategic-Udy Metallurgical and Chemical Processes, in Niagara Falls, Ont., has been completed—demonstrating the process to be practicable and profitable on a commercial basis. The planned output capacity of the open pit operation is 70,000 tons of ferromanganese and 75,000 tons of pig iron annually.

Heath Steele Mines has cut back operations at its lead-zinc-copper property in the Newcastle area. Production was started early 1957 but full capacity has never been reached. The mine and plant have a rated capacity of 1,500 tpd and at present the company plans to continue on the tune-up rate of less than 500 tpd. Depressed prices for base metals are responsible for the curtailment. American Metal Climax Inc. holds 75% control and management of the operation; International Nickel Co. of Canada holds the remaining 25% interest.

ONTARIO

Encouraging results have been obtained by Rio Canadian Exploration in diamond drilling at its molybdenum prospect in Echo Twp., Sioux Lookout area. A deposit of better than 300,000 tons grading 0.55% MoS_2 to shallow depth was indicated in a recently completed diamond drilling program. Some 17 holes were put down for a total of 5,390 ft. The drilling indicated values over strike length of 2200 ft but tonnage estimate



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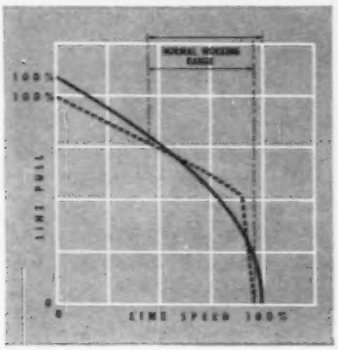


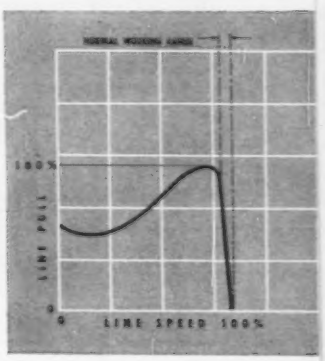
Power Performance of LIMA'S Optional Electrical Power Unit.

Power performance curve of Lima's electrical power unit (solid line) compared with that of a diesel-torque converter unit (dotted line). As can be seen, the line pull will constantly increase through a long pull down in speed range, depending upon the load applied. Even under extreme loading the motor will pull down in speed only slightly and can never be stalled.

Power Performance: AC Electric motor with direct drive—

The motor speed and torque varies as shown for line speed and pull.

With a pull down in speed of only 3% to 5%, torque rises too fast. The motor will stall quickly after peak torque is reached. Workable speed range is small, stalls are frequent.



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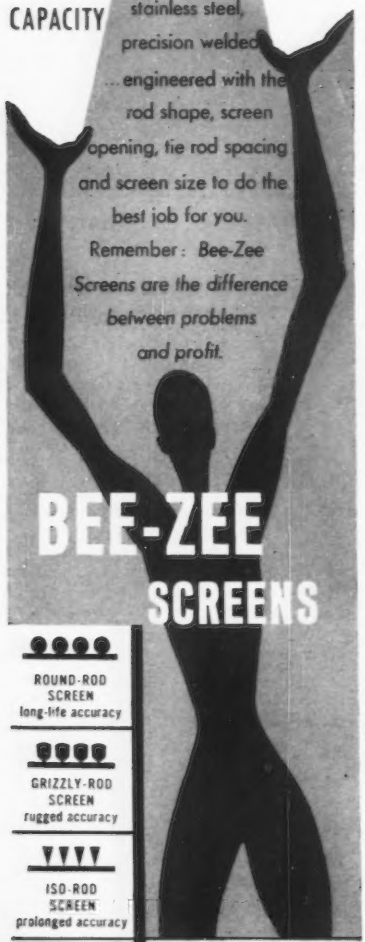

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Ontario (*Continued*)

was confined to only 1700 ft. Further fill-in drilling is required to determine the full extent of the zone.

A unique iron treatment operation is being prepared for production in Steep Rock Lake area by Canadian Charleson Ltd. a wholly-owned subsidiary of Charleson Mining Co., Hibbing, Minn. The company is currently erecting a $2-million beneficiating plant to upgrade extensive hematite-bearing glacial gravel deposits on its 1,000-acre property adjoining Steep Rock Iron Mines. Capacity of the plant is upwards of 2-million tons of gravel a year and known reserves are estimated sufficient to maintain this rate for at least 25 years.

Caland Ore Co. has passed the half-way mark on drainage of Steep Rock Lake, according to the annual report of Inland Steel Co. Production target is 1960 with a high quality ore being shipped from the huge project. Work has begun on the laying out of the pit.

Expansion of International Nickel Co.'s operations in Ontario and Manitoba will increase annual nickel production capacity to 385-million lb in 1961, according to the annual report.

Sinking of the Thompson shaft at Moak Lane, Man., to 2100 ft is proceeding on schedule and is expected to bottom out in the autumn. Thompson mine (75-million lb nickel per year) will be produced first. Reports also list "tests of ore possibilities at the company's Coppermine River concession in the Northwest Territories.

Geco Mines is now running at full capacity of 3,500 tpd at its new base metal operation in the Manitouwadge area. Grade is averaging 2.2% copper, 2.0% zinc and 1.35 oz silver per ton. Presently only two products are being turned out, a copper concentrate and a zinc concentrate.

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NEWFOUNDLAND

Resumption of two-shift mining and milling operations by Newfoundland Fluorspar Ltd. in St. Lawrence, Newfoundland, following a complete plant changeover, was announced recently.

Main changes to mine and plant were: excavation of ore passes underground; installation of an underground primary crusher and belt conveyor to transport ore from the crusher to skip loading pockets; installation of new skips and skip loading equipment; erection of a new hoist house and installation of a new hoist; erection of a new 500 tons capacity shaft bin and major changes to the surface crushing plant.

BRITISH COLUMBIA

Efforts by government, industry and labor to keep British Columbia's big Britannia copper mine in operation have failed.

Howe Sound Co. of New York closed the mine March 1, because "continuing decline in the copper market has made it impractical to prolong the operation, even with the assistance which has been received."

The mine would have closed last December but Federal and B. C. provincial governments set up a $20,000-a-month subsidy that enabled the company to continue operation on a reduced scale.

Mines Minister Kenneth Kiernan this month indicated the B. C. government will bow to constant pressure by the industry to revise its year-old mining legislation governing tenure.

The new tenure legislation, passed at the 1957 session of the House, instituted a leasing system under which a mining operator has five years to formulate development and production plans.

At the end of five years he may obtain a 21-year lease for production. This lease is renewable.

Since the legislation was passed, the industry has condemned it because it limits "security of tenure". It has been held responsible for discouraging mining development in the past year.

The change will be in detail and not policy, Kiernan reports.

The government is anxious to find a "middle ground," he said.

"We cannot, however, return to the

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British Columbia *(Continued)*

crown-granting of minerals," he said, "nor to any system of tenure that permits the committing of B. C.'s key mineral resources to the future requirements in some far distant day of some company not operating within the province."

Noranda Exploration Co. Ltd. has moved into B. C.'s Highland Valley. Wholly-owned subsidiary of Noranda Mines Ltd. has concluded a "lease-option" agreement with Midnight Consolidated Mines Ltd. of Vancouver, covering 54 claims adjoining Craigmont property in the Highland Valley, in the Merritt area.

Evaluation work on Craigmont Mines Ltd.'s Highland Valley property has confirmed the presence of "massive copper-iron orebody in the multi-million ton category."

Beaver Lodge Uranium Mines plans to open a gold-silver-base metal mine near Denver this summer, president D. F. Farris said.

Giant Mascot Mines Ltd. is negotiating with McPhail Engineering Co. of Tacoma, for the American firm to take 100,000 tons of barite from tailings at its Spillimacheen mine.

Company estimates it has 800,000 tons of tailings, averaging 30 to 50% barite. Original production will be 100 tpd.

NORTHWEST TERRITORIES

Mineral potential of Canada's Northland is being assessed through huge mapping projects outlined by Federal Minister of Transport George Hees at the annual Prospectors' and Developers' Convention of the Alberta and Northwest Chamber of Mines held in Edmonton during February.

He reported that geological survey crews operating with helicopters this year will map a large area of the southeastern part of the District of Mackenzie in the Northwest Territories. A $6-million project to photograph the Arctic Islands for subsequent detailed topographical mapping is also being launched. This was described as the largest photographic assignment ever undertaken in the Free World.

IN LATIN AMERICA

PANAMA

Both Alcoa Minerales, Inc. and the Kaiser Exploration Co. are engaged in obtaining bauxite exploration concessions from the Government of Panama. The area in which they are particularly interested is close to the northern Panamanian city of David.

Contracts call for paying the government 30% of the net profits received

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Conveying
Troublesome
TRAMP IRON

DETRAMP
Stops this saboteur by timely detection and warning

The Detramp electronic iron detector is a simple, inexpensive and reliable means for detecting tramp iron and steel on conveyor belts.

A valuable contribution to automation in mining and milling, Detramp employs a rugged, proven and stable electronic circuit of unique design. Following are some of the features of this versatile system:

Detection signals consist of howler, light and marker or any combination of these devices.

The marker deposits a spot of lime at the location of the tramp material.

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Plug-in delay stop unit and manual over ride switch permits removal of tramp without stopping belt.

Sensitivity adjustment makes it possible to allow small sizes to pass.

Will detect most high manganese steels.

The apparatus is simple to install ... gives years of trouble-free service.

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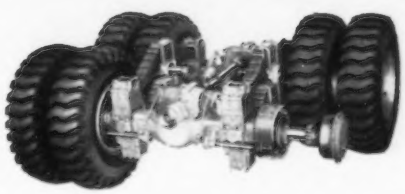
Specialists in instrumentation, control and automation for milling and smelting. Consulting, engineering, design and installation services for all types of system controls.



Macks have the easy maneuverability that allows faster spotting and dumping . . . the power and brawn to move the heaviest loads over rough terrain or open highway. And Mack's Balanced Bogie with Power Divider (that applies torque to the wheels with traction) makes Macks all-weather, all-terrain performers.

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You can speed up your loading-dumping cycles with shovel-hustling Mack trucks. Only Mack offers you a heavy-duty unit that is engineered for every hauling job. From versatile 7-ton jobs to big-capacity 15-ton jobs, on up to burly, super-capacity 34-ton models, there's a Mack that will do your toughest, most demanding hauling job best. Your Mack distributor will be glad to show you on-the-job proof why Mack's minimum down time, low maintenance costs and economical performance mean a more profitable operation for you. Mack Trucks, Inc., Plainfield, New Jersey. In Canada: Mack Trucks of Canada, Ltd.

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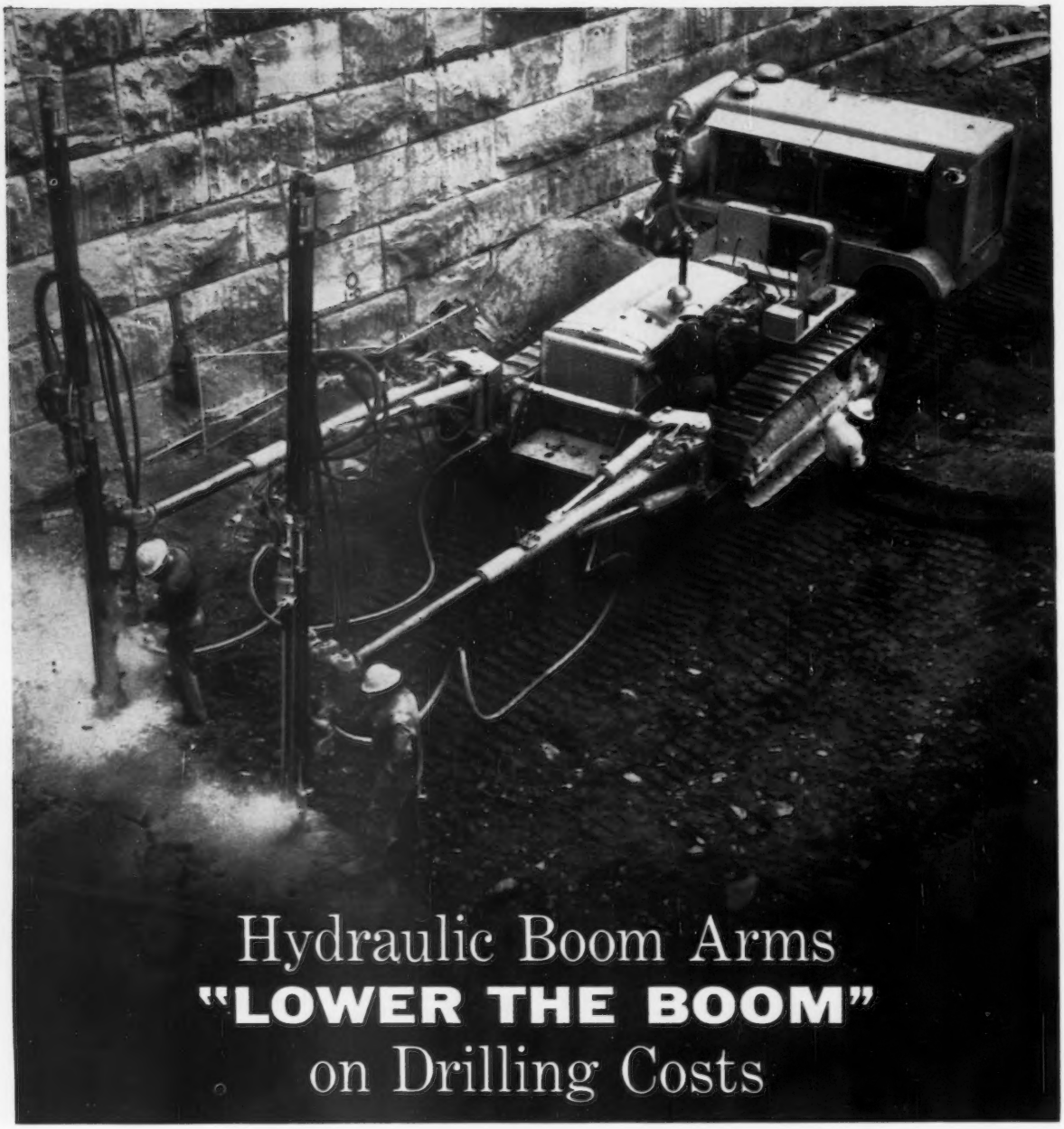

Hydraulic Boom Arms "LOWER THE BOOM" on Drilling Costs

H-Booms have extra-capacity, double-acting hydraulic cylinders that retract and extend, swing or elevate in a hurry—yet pressures are moderately rated. There's no creeping or drifting! Boom can be extended 6 feet . . . that's an extra foot of length to afford better spacing of holes and greater area coverage without moving the rig.

Heavy-duty, Chicago Pneumatic H-Booms can be easily mounted on mine car, track or rubber-tired jumbos. It's a highly productive drilling unit when used on your old tractor. Write for more detailed information. *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, New York.*

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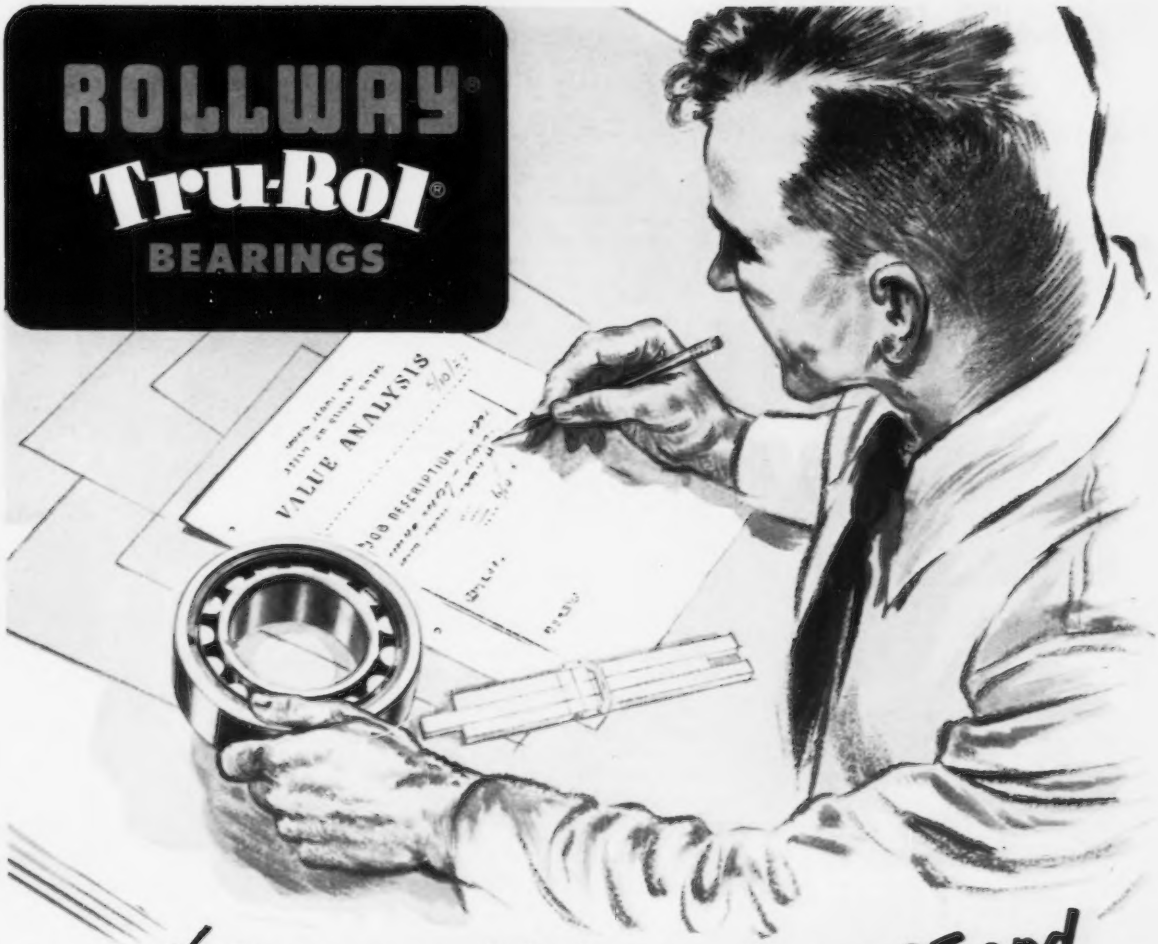

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The Tru-Rol segmented steel retainer is the strongest, most durable available in commercial-grade bearings. Its separator segments are formed to the curvature of the roller for true axial alignment. In combination with rollers crowned to provide equal load distribution, it withstands heavy shock and reversing loads over long periods.

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Sturtevant crushing and grinding machinery answers the long life top-load production problem for medium to small size plants. Many Sturtevants have been operating above rated capacities for more than 25 years, and *without a major repair.*

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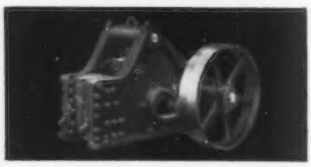
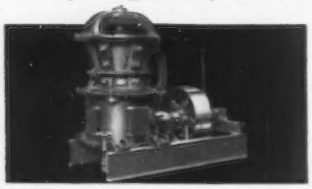
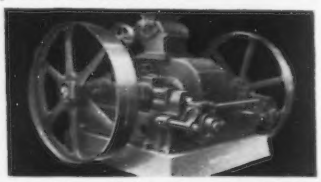


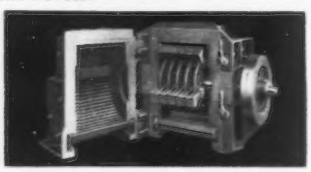
Jaw Crushers — Produce coarse (5 in. largest model) to fine (⅛ in. smallest model). Eight models range from 2 x 6 in. jaw opening (lab model) to 12 x 26 in. Capacities to 30 tph. All except two smallest sizes operate on double cam principle — crush double per energy unit. *Request Bulletin No. 062.*



Rotary Fine Crusher — Reduce soft to medium hard 3 to 8 in. material down to ¼ to 1¼ in. sizes. Capacities up to 30 tph. Smallest model has 6 x 18 in. hopper opening; largest, 10 x 30 in. Non-clogging operation. Single handwheel regulates size. *Request Bulletin No. 063.*



Crushing Rolls — Reduce soft to hard 2 in. and smaller materials to from 12 to 20 mesh with minimum fines. Eight sizes, with rolls from 8 x 5 in. to 38 x 20 in.; rates to 87 tph. Three types — Balanced Rolls; Plain Balanced Rolls; Laboratory Rolls — all may be adjusted in operation. *Request Bulletin No. 065.*



Hammer Mills — Reduce to 20 mesh. Swing-Sledge Mills crush or shred medium hard material up to 70 tph. Hinged-Hammer Pulverizers crush or shred softer material at rates up to 30 tph. Four Swing-Sledge Mills with feed openings from 6 x 5 in. to 20 x 30½ in. Four Hinged-Hammer Pulverizers with feed openings from 12 x 12 in. to 12½ x 24 in. *Request Bulletin No. 084.*

**Reports Manager W. Carleton Merrill concerning Sturtevant Swing-Sledge Mill at James F. Morse Co., Boston.*

STURTEVANT MILL COMPANY
101 Clayton St., Boston 22, Mass.

Rainier; by Plumbbob, Out of Plowshare

JOHNSON: *a modern smithy*

WITHOUT a spreading chestnut tree for miles, a group of modern blacksmiths are following the Atoms-For-Peace admonition and forging peaceful tools from the most awesome of our weapons.

The most spectacular experiment so far in the "Plowshare Project" of AEC and the University of California's radiation laboratory at Livermore, Calif. was the recent "Rainier Shot" in Nevada. (See p 21.) Rainier, in the arcane world of code names, was a part of Operation Plumbbob, which is a part of Plowshare.

Dr. Gerald W. Johnson, test director for Rainier and author of the news article on p 21, was born in Spangle, Wash. and took his bachelor's and master's degrees at Washington State College. In 1947, Dr. Johnson took his Ph.D. in physics at UC at Berkeley, following Naval service at the armor piercing proving grounds at Dahlgren, Va.

Between war-end and his participation in Plumbbob as a member of the physics department at UC at Livermore, Dr. Johnson taught at Washington State, researched crystal growth and neutron structure at AEC's Brookhaven Lab, and served as a special assistant to the AEC director of research.

He married the former Mary Kay Skidmore of Spokane in 1940. The couple has three children; Susan, 12; Russell, 10; and Richard, 3.

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Unmatched holding power on the shaft...

New mounting simplicity.

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With the patented Dodge Back-up Bar, welds of full rim thickness are achieved—and the ultimate in strength is assured by submerged arc process welds.

Taper-Lock Steel Conveyor Pulleys *hold*. Taper-Lock provides the equivalent of a shrunk-on fit—there is no "walking" on the shaft. Mounting and demounting are simple. Pulley and bushings mount as a unit. Alignment is easy. And the tapered bushing is wedged into place merely by turning the mounting screws. It is "unlocked" by using the mounting screws as jack screws.

Available in diameters from 6 inches to 8 feet—all face widths. Standard or special rubber lagging available. Ask your local Dodge Distributor—or write us for bulletin.

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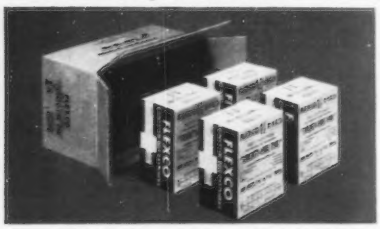
TWENTY-FIVE COMPLETE SETS OF FLEXCO HD BELT FASTENERS NOW AVAILABLE IN ONE EASY-TO-HANDLE ECONOMY BULK PACKAGE

There's no need now to carry several 10-set boxes to the job—every "25-PAK" contains 25 complete sets of FLEXCO Fasteners (bottom plates, top plates, clips, nuts and bolts) . . . enough FLEXCO Fasteners to join common belt widths (for example: one "25-PAK" box, size 1½E, will join a 36" belt.) Our savings from bulk-packaging are passed on to you!
Label on each "25-PAK" box has chart indicating the number of FLEXCO HD Fasteners to use for given belt widths.



Standard shipping carton contains four "25-PAK" boxes of one size fastener. Keep a supply of "25-PAKS" on hand. Easy to store and inventory, sturdy boxes and shipping cartons have many uses.

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FOR THE SPLICE OF A LIFETIME

Panama *(Continued)*

from the export of any bauxite located. In addition, an export tax of slightly under ½c per ton would be paid. Informal subsurface exploration work by geologists from both companies has been under way in both Panama and Costa Rica for some time.

MEXICO

A Mexican company, financed by U. S. capital, is planning to erect two 100 metric tpd flotation mills and to reactivate mines abandoned 40 years ago.

Manuel E. Romero, general manager, Cia. Minera Guebeche, S.A., said that a Houston group led by C. H. Boswell will finance the construction of the mills —each to cost about $100,000.

Control of Mexico's titanium dioxide market is the aim of both Glidden and Du Pont Companies as they race to construct a plant in that country.

Glidden is dismantling and shipping the production equipment from its Baltimore-St. Helena installation for a plant to be built by its licensee, Industrias Quimicas Basicas of Mexico, S.A.

Du Pont, S.A. de C.V. is rushing to complete a $2.8-million, 5,000-7,000 tpy TiO_2 plant at Tampico.

Anaconda Co.'s annual report notes that drilling below Cananea Consolidated Copper Co.'s Colorado orebody "has indicated a large tonnage of disseminated copper mineralization having the size and grade of a major porphyry copper deposit." The firm notes that future economic mining of the deposit will depend on actions and attitude of the Mexican government.

CHILE

Japanese interests have been developing the Portezuelo copper mine in Antofagasta province and Nippon Mining Kusuo Okabe's President who recently visited Chile said that he hopes his enterprise will reach a monthly production of 150 tons of cement copper a month from this mine.

IN AFRICA

A consignment of 8,000 tons of South African pig iron is now awaiting shipment to Europe from Durban harbor. This is a trial parcel and may be the forerunner of further shipments this year. Exports of the metal have been extremely irregular in the past, going as high as 35,000 tons in 1954 and 100 tons in 1956. But the latest export deal is a natural result of the tremendous

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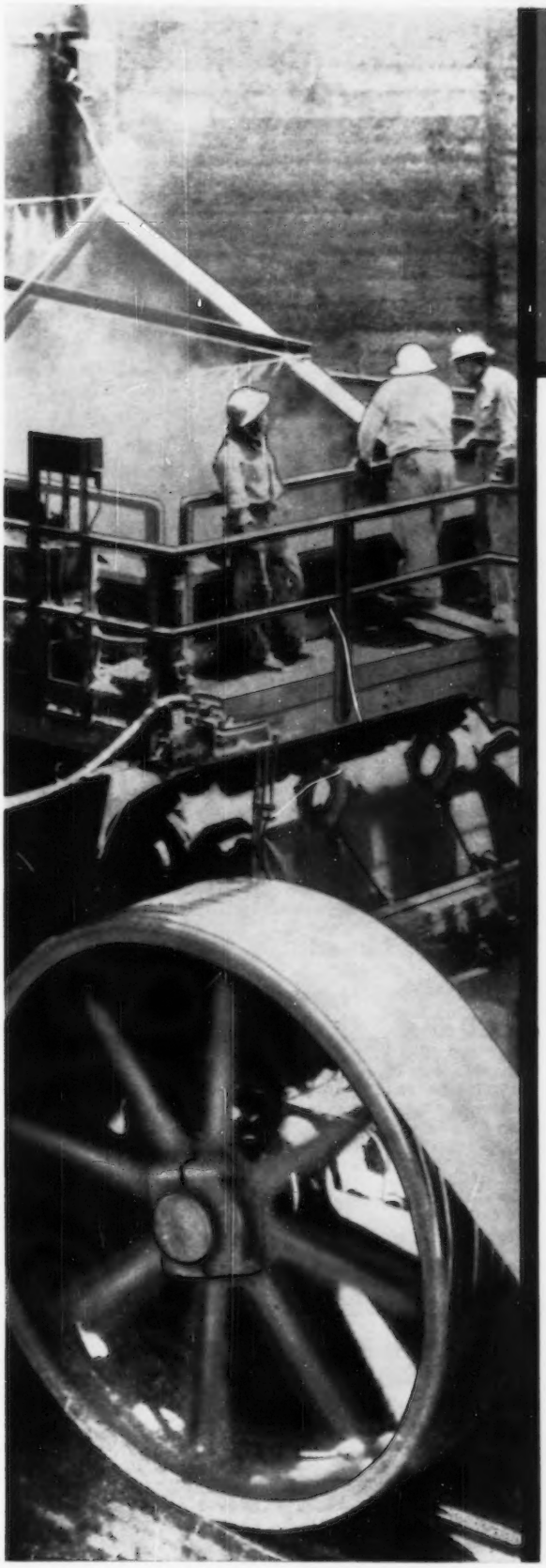

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. . . No one knows this better than the men in the field who are now operating BIRDSBORO-Buchanan Deep Frame primary jaw crushers. *Deep frame* means longer swing jaws for faster crushing to smaller sizes. You are assured of positive nipping action and less slippage. Of course, performance is best measured in figures. They are available to you along with other important design information through your Birdsboro representative. *Main Office, Engineering Department and Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa. *World-Wide Agent Representation.* Contact home office for nearest representative. *Canadian Representative & Manufacturer:* John Inglis Co., Ltd., Toronto, Canada.

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Africa *(Continued)*

expansion recorded by the Union's iron and steel industry within the last year or two.

S.A. Minerals chrome operations at Rustenburg, Northern Transvaal ceased on March 15. Decision results from the continued weakness for the company's ore in world markets.

South African nickel producers have reached a position, where, for the first time in a long while, production capacity exceeds demand. It's estimated that unless world production changes unpredictably, shortages of the past years are unlikely to recur.

IN AUSTRALIA

Several Australian operators have taken steps to reduce their output of metals by an average 10% but it's not expected that further reductions in production would be ordered. In spite of price falls, fiscal position of most of the larger Australian mines is extremely strong and some inventory-building would take place before further cuts are considered.

United Uranium N. L. expects to begin production of uranium oxide at the converted Northern Hercules treatment plant near Pine Creek before the end of 1958. Sales are expected to be directed mostly to U. K. Atomic Energy Authority. Ore will come from the El Sharana mine and 20,000 tons will be carted to the former gold treatment plant in the coming dry season.

Australian Uranium Corp. N. L. has discontinued operations at its Adelaide River mine. This followed a refusal of the Australian AEC to grant assistance to this company.

Tonnage per manshift in the Mining Dept. of Mt. Isa Mines Ltd. (all ores) rose to a record 7.2 tons. Total throughput of the mill in 1957 was a record 1,395,720 tons of ore made up of 703,550 tons of lead-zinc sulphides and 688,755 tons of copper sulphides treated experimentally in the heavy media section.

IN EUROPE

POLAND

Geological research work conducted in the Sierozsowice and Lublin areas confirmed the existence of a copper-bearing ore with average content of about 1.4% copper. This so far is the richest Cu-content ore found in Poland. The seam measures a total of 13.66 miles, and is about 3.73 miles wide. Ore is about 2,164 ft deep in 7.23 ft thick copper bed.

Polish geological teams are systematically checking all Polish coal mines for traces of uranium radiation. "Gazetta Pomorska" (a Pomeranian daily newspaper) recently stated that team findings will produce the first thorough estimate of Poland's uranium deposits.

USSR

Russia's biggest deposits of titanium and zirconium have been discovered on the Samotkan River, one of the Dneiper tributaries, and, according to Soviet Weekly, can be mined by open pit methods.

BULGARIA

According to reports, the non-ferrous metals industry will play a vital role in Bulgaria's 1958 industrial output—350,000 metric tons of non-ferrous concentrates are planned for this year. Of this total production, 30% will be exported.

GREECE

A 10-year concession for the development of magnesite mines at Vavdon, Chalkis, Greece, has been granted by the Greek government to the Austro-American Co., Salzburg, Austria. The company will invest $800,000 to modern-

ALLUVIAL DEPOSITS

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STOODY 1030

A new, low-cost hard-facing electrode that excels in *POSITION* WELDING!

Here's a new Stoody hard-facing rod especially made to fulfill several "musts"! *Stoody 1030 is unusual in its all-position weldability!* This means easier, faster hard-facing on much larger equipment...equipment which has to be hard-faced in the yard or on the job...equipment which can't be positioned to facilitate a down-hand welding setup!

TOP WEAR RESISTANCE within its price class! Stoody 1030 fits between Stoody Self-Hardening and Stoody 21 in wear qualities, favoring the latter. It satisfies all requirements where good abrasion resistance is essential, at the same time saves several cents per pound.

EXCELLENT COMPRESSIVE STRENGTH adapts Stoody 1030 to such applications as roll crushers; also sides, lips and teeth of power shovel buckets; drag lines and clamshells; carrying scraper blades, runners, etc.

APPLICATION—Either AC or DC, with a choice of straight or reverse polarity on DC. 3/16" rods weld at 140-220 amps, 5/16" rods at 225-275 amps. Straight polarity induces very fast burn-off and minimum penetration. Deposits set up rapidly, easily holding edges of welds. Spatter is negligible; overall application efficiency is approximately 78%. No slag covering results, makes easy multiple passes. Complete size range from 5/32" to 5/16".

Try Stoody 1030 on your next job—test its position welding advantages and wear resistance...make extra savings with its low cost!

Literature on Stoody 1030 is available from your Stoody Dealer (check the Yellow Pages of your phone book) or write direct.

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"Prior to using LUBRIPLATE, we were replacing shaker screen bearings within 60 to 120 days due to lack of or faulty lubrication. Since we started using LUBRIPLATE seven years ago, we have only replaced two shaker screen bearings and these because of natural wear. We now use LUBRIPLATE for general lubrication throughout our plant."

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REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE GREASE AND FLUID TYPE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.

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Greece *(Continued)*

ize installations and equipment in the Greek mines, with $150,000 to be spent in Austria for the purchase of machinery. Greece's 100,000 tpy magnesite production is certain to be boosted this year.

ITALY

The Sicilian government will submit a bill for approval calling for a $1-million appropriation to explore radioactive minerals in Sicily.

A prospecting team of geologists, geographers, mineralogists, prospectors, and physicists will be organized and will work in collaboration with the Italian National Institute of Geophysics.

IN THE PHILIPPINES

Atlas Consolidated M & D Corp. milled 312,494 tons at its Toledo mill in January, with production of 5,758 tons of concentrates averaging 28.3% copper. A continued water shortage due to the prolonged drought in the area held production down below the December total. Copper output was 3,264,00 lb, compared with 3,896,000 lb in December. For the full year 1957, the company reported a production of 38,122,000 lb copper (23,957,000 lb in 1956). In addition, the company recovered 12,238 oz gold as by-product from copper ores, as well as 14,000 tons of pyrite. Atlas shipped 162,286 tons of iron ore to Japan from its Mati mine. Total value of all shipments in 1957 was $11,450,000.

Lepanto Consolidated milled 37,300 tons in January to produce 4940 tons of concentrates estimated to contain 2,472,970 lb copper and 4190 oz gold. Millheads average 3.49% copper and 0.144 oz gold per ton.

Itogen mill in Gaguio recovered 3075 oz gold in January from 19,000 tons milled. Baguio Gold Mining Co. recovered 2523 oz gold from milling 12,400 tons, valued at $167,800.

IN ASIA

MALAYA

Cutbacks in production and low prices presently obtained for Malaya's tin are causing hardships to miners with a possible threat of serious unemployment throughout the country, tin mining circles reported.

Asian miners responsible for nearly half of the nation's total production say they are the hardest hit and are now asking for government assistance in the form of loans against their Buffer Stock contributions.

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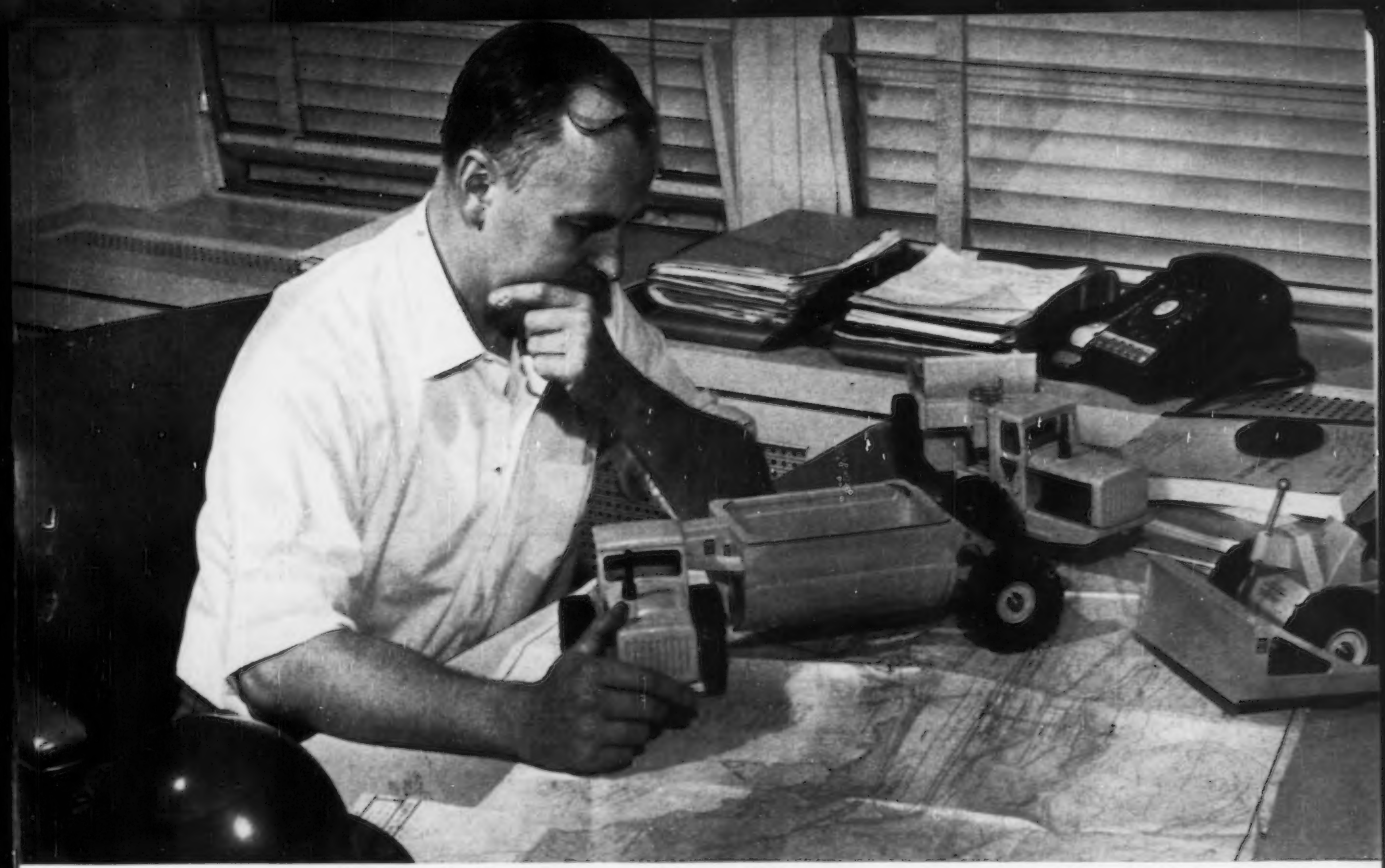

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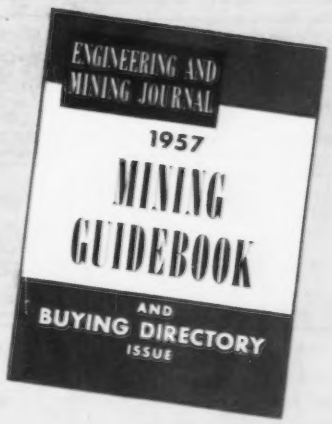

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Open Pit Mining Exploration
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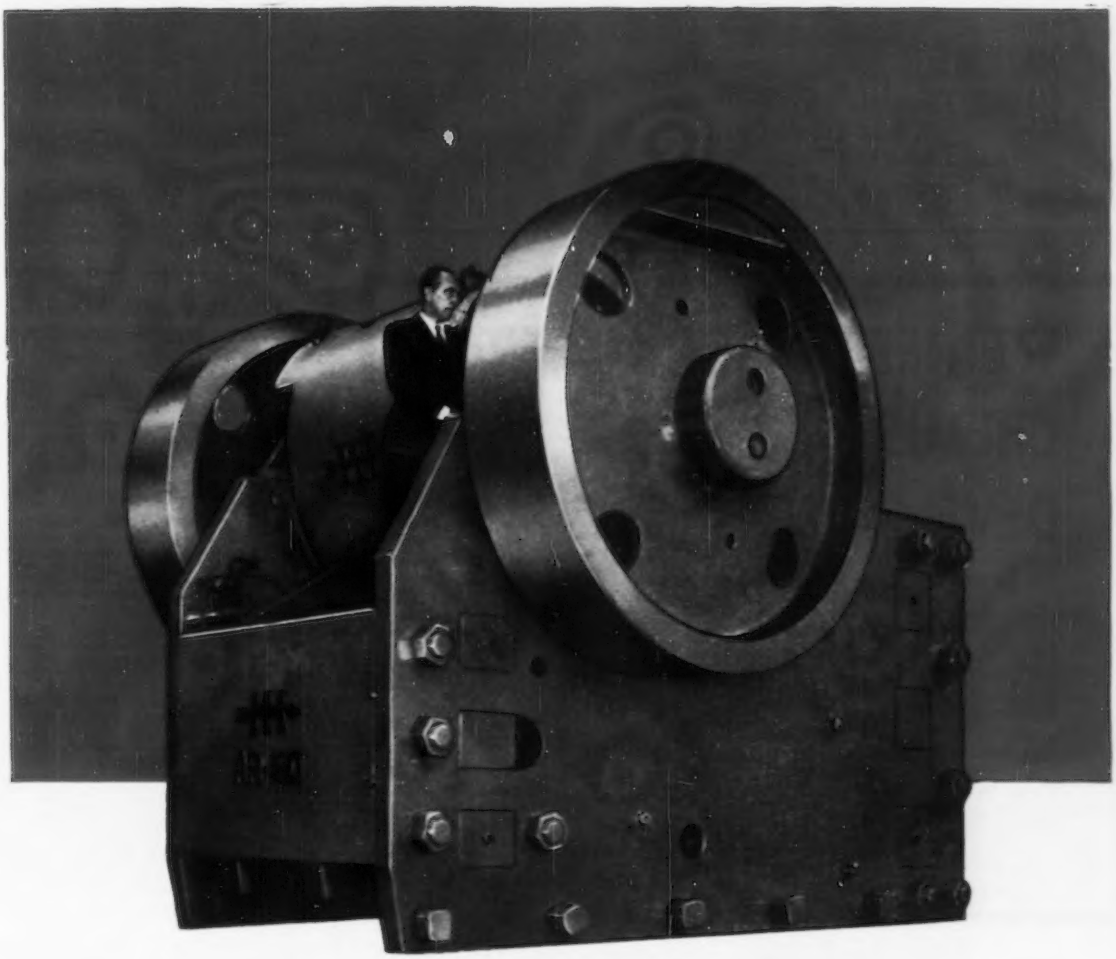

Boulder Crusher AR-180

Six of these huge crushers are being supplied for use underground in Swedish iron mines at Kiruna and Malmberget.

The AR-180 with its 71" x 55" feed opening is the largest single-toggle type Jaw Crusher in the world. It can accept blocks of iron ore up to 10 tons and reduce these to 16" thickness. It can be dismantled into component parts suitable for transportation and erection underground.

Built in three sizes

TYPE	FEED OPENING	SETTING	MIN. MINE SHAFT DIMENSIONS	NETT WEIGHT
AR–120	47" × 35"	12"	36" × 73"	81500 lbs
AR–150	59" × 47"	12"	57" × 89"	170000 lbs
AR–180	71" × 55"	16"	60" × 98"	256000 lbs

Single-toggle design — simple and strong.
Frame in sections, with interlocked bolted joints.
Side frames for the AR-180 and AR-150 are of heavy steel plate.
SKF spherical roller bearings — grease lubricated throughout — avoiding oil leakage. Low idling power consumption.

MH **MORGÅRDSHAMMAR**

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The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

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The advertising rate is $25.00 per inch for all advertising appearing on other than a contract basis. Frequency rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

$1.50 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.
Position Wanted—The rate is one-half of the above, payable in advance.
Box Numbers—counts as 1 line.
Discount of 10% if full payment is made in advance for 4 consecutive insertions.
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Send NEW ADS or Inquiries to Classified Advertising Div. of ENGINEERING & MINING JOURNAL, P.O. Box 12, N. Y. May issue closes April 22nd.

WE NEED A TOP MINERAL CHEMIST TO HEAD NEW DEVELOPMENT PROGRAM

Tremendous Opportunity for Right Man

Our nationally known, ninety year old, multi-plant company, manufacturing organic compounds in broad distribution, needs a graduate chemist or mining engineer to head the development and service of our new program devoted to reagents. You must have imagination, drive, and broad practical experience in beneficition, as well as experience in reagents. You will reside in the New York area and also do some field technical service.

Please send a complete resume of your background. Our personnel knows of this ad. *Salary open.*

P-7520 Eng. & Mining Journal

Class. Adv. Div., P.O. Box 12, N. Y. 36, N. Y.

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B.S. or M.S. degree Industrial or Mechanical Engineering preferred with 5 years industrial engineering experience including 2 years supervisory capacity. Should have extensive experience methods engineering, material handling, time study, wage incentive, and job evaluation.

MINE FOREMEN

for underground mine operations. B.S. degree in Mining Engineering required and at least 3 years underground metal mining experience and year in supervisory capacity. Interested principally in individuals with qualifications for future advancement.

Excellent opportunities large copper company. Chile, South America. 3 year contract, transportation both ways and salary while traveling paid by Company. In reply give complete details.

P-7512 Engineering & Mining Journal
Class. Adv. Div., P.O. Box 12, N. Y. 36, N.Y.

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With broad experience in executive and management positions, including production and exploration in base, precious metal and uranium mining. Experienced with modern trackless and standard mining methods. Competent administrator and organizer. Exceptionally qualified for performance and leadership. Presently employed prominent mining company. Desires new position in mining or allied field.
PW-7527 Engineering & Mining Journal
68 Post St., San Francisco 4, Calif.

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CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

POSITION VACANT

Research Metallurgist (Ore Beneficiation) Required for Island of Cyprus. Metallurgist or Mining Engineer well trained in metallurgy, with aptitude and interest primarily research. To improve current practice in 100 ton per hour copper flotation mill and test various grades and mixtures of massive sulphide ores. Age to 45. Three year contract. Salary open. Submit complete record and references list with first reply. Cyprus Mines Corporation, 523 West Sixth Street, Los Angeles 14, California.

POSITIONS WANTED

Placer Engineer, dredging, hydraulic, open cast. Tin, gold, platinum, columbite, tantalite. PW-6928 Engineering & Mining Journal.

Mining engineer wants responsible position; 20 years experience in all phases of the industry. Reply PW-6484, Engineering & Mining Journal.

Mining Engineer 25 years experience in exploration, development and operation in States and abroad. Supervisory position desired. Employed. PW-6991, Engineering & Mining Journal.

Manager, Gen. Supt., professional mining engineer and geologist, wide foreign experience PW-6938, Engineering & Mining Journal.

GEOPHYSICIST or GEOLOGIST

San Francisco Peninsula technical firm needs Geophysicist or Geologist with college degree to head up promotional and service activities relating to growing line of geophysical instruments. Desire individual with strong technical and managerial competence with flair for selling in highly specialized research market. Must have good working familiarity with electronic instruments. Send resumes stating salary requirement to

P-7629 Engineering & Mining Journal
68 Post St., San Francisco 4, Calif.

POSITIONS WANTED

Second year engineering student seeks summer mining job. 24, single, 3 years army, made seargent, 2 years Oregon State, second year Sierra College. Jack Kendall, c/o Mrs. Thorna, Rt. 1 Box 1818, Auburn, California.

Mine Captain, B.Sc. degree, P.Eng., age 39, Canadian, married, children. Experienced underground supervision, mine planning & development both trackless & standard methods. Engineering experience covering shaff siking, long-hole blasting & layout & development equipment. Desires responsible position in the U.S. or Canada. PW-7507, Engineering & Mining Journal.

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JAW CRUSHERS
- 6—2¼" x 3½" New Morse Lab Crushers
- 6—4" x 6' New Morse Lab Crushers
- 1—6½" x 7" Hendy Jaw Crusher
- 1—9" x 16" Day Jaw Crusher
- 1—8" x 15" Wheeling Jaw Crusher
- 1—9" x 16" Universal Jaw Crusher
- 1—10" x 16" Universal Jaw Crusher
- 1—9" x 36 Cedar Rapids Jaw Crusher
- 1—42" x 48" Traylor Jaw Crusher

BALL AND ROD MILLS
- 1—4' x 4' Marcy Ball Mill
- 1—6' x 4' Hardinge Conical Ball Mill
- 1—6' x 6' Allis-Chalmers Ball Mill
- 1—7' x 5' Allis-Chalmers Ball Mill
- 1—8' x 22' Hardinge Conical Ball Mill
- 1—3' x 7' Morse New Rod Mill
- 1—4' x 10' Hardinge Rod Mill
- 2—5' x 10' Traylor Rod Mills
- 1—5' x 10' Hendy Rod Mill

CLASSIFIERS
- 1—6' x 18'4" Dorr Duplex Rake Classifier
- 2—8' x 18'4" Dorr Duplex Rake Classifiers
- 1—18" x 16' New Morse "TrueLine" Simplex Rake Classifier
- 1—24" x 12' Wemco Simplex Spiral Classifier
- 1—45" x 17' Akins Simplex Spiral Classifier
- 1—72" x 32' Wemco Duplex Spiral Classifier
- 3—10" x 10" St. Joe type Hydraulic Classifiers

CONCENTRATING TABLES
- 10—Deister Diagonal Deck Right Hand
- 10—Deister Diagonal Deck Left Hand
- 5—Deister Overstrom Diagonal Deck Left Hand

FLOTATION MACHINES
- 1—#7 Morse "Jetair" Hydra-cell, 22" x 22"
- 1—4-cell Morse-Weinig, 24" x 24"
- 1—2-cell Fagergren, 66"
- 1—4-cell Fagergren, 66"
- 1—8-cell Fagergren, 56"
- 1—2-cell Agitair #24
- 1—Denver unit cell #250
- 7—2-cell Fagergren, 62"
- 1—6-cell Fagergren, 18" Pilot Machine
- 1—4-cell "Agitaire" #15 Pilot Machine

FILTERS
- 1—6' x 3' Dorrco Internal Drum Type Filter
- 2—3' x 4' Oliver Drum Filters
- 2—4" x 2' Morse Drum Filters
- 1—4' x 8' Eimco Drum Filter
- 1—6' x 8' Morse Drum Filter
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- 2—6' x 2' disc Morse Leaf Filter
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- 1—4' x 2' disc Denver Filter
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THICKENERS
- 1—45' x 12' Dorr Thickener
- 1—24' x 8' Dorr Thickener
- 1—22' x 8' Denver Thickener

BELT CONVEYORS
- 1—14" x 20' Conveyor
- 1—18" x 41'2" Conveyor
- 1—17" x 115' Conveyor
- 1—30" x 135' Conveyor
- 1—24" x 77' Conveyor
- 1—20" x 68' Conveyor
- 1—20" x 136' Conveyor
- 1—16" x 23' Conveyor

LOCOMOTIVES—DIESEL
- 1—2-ton Goodman Diesel, 18" ga.
- 1—4-ton Goodman Diesel, 18" ga.
- 1—6-ton Mancha Diesel, 24" ga.
- 1—Ruth Diesel, 24" ga.

LOCOMOTIVES—BATTERY
- 6—1½-ton Mancha "Little Trammers," 18" ga.
- 1—1½-ton General Electric Trammer
- 3—3½-4 ton Mancha Locomotives, Titan "A"
- 1—4 ton Westinghouse-Baldwin Locomotive
- 2—6 ton General Electric Locomotives
- 2—7 ton General Electric Locomotives
- 1—7 ton Atlas Locomotive
- 3—8 ton Ironton Locomotives
- 2—8 ton Goodman Locomotives
- 2—8 ton General Electric Locomotives
- 1—9 ton Whitcomb Locomotive
- 4—10 ton Atlas Locomotives

LOADERS
- 17—Eimco 12B, 18" ga.
- 8—Eimco 21, 18" & 24" ga.
- 3—Gardner-Denver Model 9, 18" ga.
- 1—Joy HL3, 18" ga.
- 1—Joy HL20, 24" ga.

AIR SLUSHER HOISTS
- 4—Ingersoll-Rand Model A5NNOH
- 1—Joy Model FF211
- 1—Ingersoll-Rand Model HNN-1J

FANS AND BLOWERS
- 6—Joy Model I-21, 5 HP Electric
- 1—Joy Model 18, 3 HP Electric
- 2—Coppus Model TM5, 2 HP Electric
- 2—Coppus Model T5, Air Driven
- 2—Coppus-Vano, Air Driven

COMPRESSORS
- 1—1710 CFM Atlas Compressor, Type AR7, Direct Driven by 300-HP Westinghouse Synchronous Motor
- 1—1085 CFM, 21" & 12" x 16" Ingersoll-Rand Imperial Compressor with 200-HP Motor
- 2—759 CFM, 18" & 10" x 14" Ingersoll-Rand Imperial Type 10
- 1—447 CFM, 14" & 7½" x 12" Ingersoll-Rand Imperial Type 10
- 1—364 CFM, 10" x 9" Sullivan, Class WG9
- 1—330 CFM, 11" & 5" x 11" Chicago-Pneumatic, 250# Pressure
- 1—293 CFM, 12" & 6" x 10" Ingersoll-Rand Imperial
- 1—285 CFM, 6" & 4¾" x 5" Gardner-Denver
- 1—198 CFM, 10" & 5¾" x 5" Sullivan Model WL60
- 1—179 CFM, 12" x 10" Ingersoll-Rand Type NE-1
- 1—161 CFM, 9⅜" & 5½" x 5½" Chicago Pneumatic Type PB2
- 1—173 CFM, 9" x 8" Chicago Pneumatic Type NSB
- 1—120 CFM, 8" x 6" Ingersoll-Rand Type ER-1
- 2— 88 CFM, 7" x 5" Ingersoll-Rand Type ER-1
- 1— 80 CFM, 6" x 5" Worthington Type HB

PUMPS
- 1—6" Fairbanks-Morse Pomona, 6-stage Deep Well Pump with 30-HP Motor
- 1—Byron-Jackson 2" x 3" x 11½", 2-stage Pump with 75-HP Motor
- 1—Byron-Jackson 3" x 4" x 11½", 2-stage Pump with 125-HP Motor
- 1—20-HP Fairbanks-Morse Pomona Vertical Turbine Pump
- 1—1½" Aurora Turbine Pump with 15-HP Motor
- 1—4" Ingersoll-Rand, 2-stage, Cameron Pump with 300-HP Motor
- 1—5" Manistee, 8-stage Pump

ACID TANKS
- 2—5700-gal. Acid Tanks, 9' x 12', Welded Steel with Koroseal Lining.

BLACK ROCK MINE AND MILL
BISHOP, CALIF.

THIS IS BUT A PARTIAL LISTING OF OUR THOUSANDS OF ITEMS OF EQUIPMENT AVAILABLE IN DENVER AND ELSEWHERE

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AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns 30 inches—to a page.

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$1.50 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, $1.50 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

Send NEW ADS or INQUIRIES to ENGINEERING AND MINING JOURNAL, P. O. Box 12, New York 36, N. Y. for May issue closing April 22nd

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MINE HOISTS: One Nordberg 10′ dia., 10′ face, double drums, both clutched, 1⅜″ rope, 1200 FPM, clutches and post brakes hydraulically operated, dial indicators and type D Lillys are gear driven, motor 1250 H.P., 2200 volts, 3 phase, 60 cycle, 443 RPM, with all controls, purchased new 1950.

Other hoists, single and double drum, 50 H.P. to 2500 H.P.

CLASSIFIERS: Two Akins and two Wemco 78″ spiral duplex, new condition.

KILNS, COOLERS & DYERS: Kilns—5′ x 40′, 5′ x 50′, 7′6″ x 40′, 6′9″ x 60′, 7′6″ x 125′, 9′ x 120′, 6′5″ x 130′ and one 10′ x 200′, ¾″ plate.

Dryers—4′ x 35′, 9′ x 50′, 8′8″ x 70′. One steam dryer 6′ x 50′.

JAW CRUSHERS: One 30 x 42″ and one 18 x 30″, sectionalized for underground use.

REDUCTION CRUSHER: Symons 3 ft. Cone, short head, with or without motor and spare parts.

PULVERIZERS Hardinge 10 x 36″ and 10 x 48″ conical mills.

LOCOMOTIVES: Diesel Electric 80 ton, 60 ton, 50 ton, 25 ton, all modern.

STEAM POWER PLANT with 3 Combustion Engineering VU-10 units, 275 PSI, 45,000 lbs. per hour, built 1954, condition like new. With all gas or oil burners and all auxiliary equipment. Located Gulf Coast.

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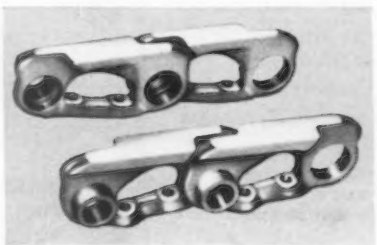

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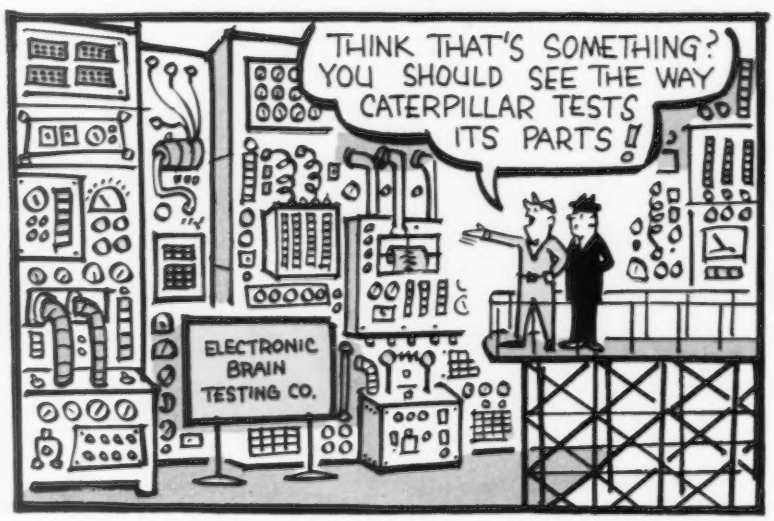

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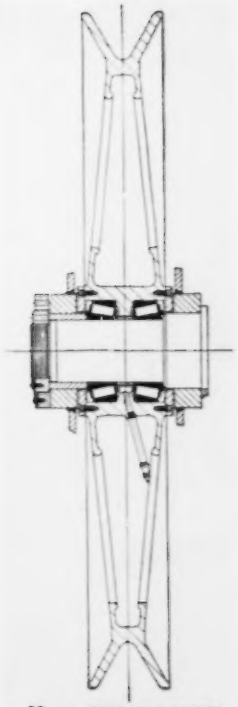

How **THE MARION POWER SHOVEL COMPANY** mounts sheaves on Timken bearings . . . to take radial, thrust loads in all combinations, keep heavy-duty sheaves in positive alignment.

New World's Record! Over 2,000,000 yards in one month on 34 Timken® bearings

A WORLD'S record of over 2,000,000 cubic yards per month has been chalked up—not once but twice—by this giant shovel built by The Marion Power Shovel Company. And no wonder! "The Mountaineer" scoops 90 tons in one bite, lifts it 10 stories, moves it 290 feet in less than one minute. To shatter records the way this giant does, you've got to keep the vital parts moving without break-down. And that takes Timken® tapered roller bearings.

34 Timken bearings carry terrific radial and thrust loads in all combinations, at critical points—including swing machinery and all hoist sheaves. Full-line contact between rollers and races gives extra load-carrying capacity. And because Timken bearings have case-carburized rollers and races—shock-resistant cores under hard, wear-resistant surfaces—they take heavy shock loads. Designed to roll true, precision manufactured to live up to their design, Timken bearings practically eliminate friction, reduce wear on integral parts. Closures are more effective, too, because Timken bearings keep housings and shafts concentric, keeping lubricant in, dirt, dust, water out.

When you buy or build machinery, look for the "TIMKEN" trade-mark on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

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TAPERED ROLLER BEARINGS ROLL THE LOAD